

UNIVERSITY OF MIAMI
Marine Laboratory

PROCEEDINGS

OF THE

Gulf and Caribbean
Fisheries Institute

SIXTH ANNUAL SESSION

MIAMI BEACH

NOVEMBER, 1953



Edited by
C. P. IDYLL

ORAL GABLES, FLORIDA

SEPTEMBER, 1954

**Gulf and Caribbean Fisheries Institute
Executive Committee**

F. G. WALTON SMITH—Chairman; Director, Marine Laboratory, University of Miami

CLARENCE P. IDYLL—Executive Secretary; Marine Laboratory, University of Miami

RICHARD A. KAHN—Chief, Economics and Cooperative Marketing Section, U. S. Fish and Wildlife Service

J. L. BAUGHMAN—Director, Las Olas Oceanographic Foundation

JOHN B. BINDLOSS—Chairman, Atlantic States Marine Fisheries Commission

BERT THOMAS—Mobile, Alabama

FRANCIS W. TAYLOR—President, Warren Fish Company

A. J. WEGMANN—President, Bagille's Seafood Company

H. D. DODGEN—Secretary; Texas Game Fish and Oyster Commission

A. J. ROBIDA—Chairman, Board of Directors, Southeastern Fisheries Association

ADDITIONAL COPIES may be obtained from The Gulf and Caribbean Fisheries Institute, The Marine Laboratory, University of Miami, Coral Gables, Florida, for \$1.00 (one dollar) per copy.

CONTENTS

OPENING SESSION

OPENING ADDRESS, A. J. Wegmann	7
--	---

INDUSTRY SESSION

HANDLING SHRIMP ABOARD FISHING VESSELS AND AT THE DOCK, Pedro Pinson	9
HANDLING SHRIMP IN THE PACKING AND FREEZING PLANT, L. W. Strasburger	11
HANDLING SHIMP IN THE BREADING PLANT, J. Roy Duggan	13
HANDLING SHRIMP IN THE CANNING PLANT, H. R. Robinson	17
THE ORGANIZATION OF A QUALITY CONTROL PROGRAM IN A FISHERY PLANT, W. F. Hampton	20
DISCUSSION, INDUSTRY SESSION	25

ECONOMIC SESSION

FINANCING OF FISHING VESSELS BY COMMERCIAL BANKS Charles T. Taylor	30
FINANCING OF FISHING VESSELS IN THE GULF STATES John J. Faubion, Jr.	35
FINANCING OF FISHING VESSELS THROUGH THE SHIP CONSTRUCTION INDUSTRY, W. F. Aberly	38
FINANCING OF FISHING VESSELS BY FINANCIAL INSTITUTIONS, R. S. Murphy	41
THE FINANCING OF THE NETHERLANDS FISHING FLEET Ph. Van Gelderen	43
FINANCING OF FISHING VESSELS IN DENMARK Erik Jacobsen	45
FINANCING FISHING VESSELS IN SWEDEN Jan-Olof Traung	49
DISCUSSION, ECONOMIC SESSION	51

BIOLOGICAL SESSION

FISHERIES DYNAMICS AND THE CONCEPT OF MAXIMUM EQUILIBRIUM CATCH, Milner B. Schaefer	53
CHANGING CONCEPTS IN FISHERY RESEARCH ON THE GREAT LAKES, Ralph Hile	64
HALF A CENTURY OF FISHERY BIOLOGY IN EUROPE Michael Graham	70

50 YEARS OF PROGRESS IN SOLVING FISHERY PROBLEMS	8
William C. Herrington	
DISCUSSION, BIOLOGICAL SESSION	9
TECHNICAL SESSION	
THE DISCOVERY OF A NEW SHRIMP BANK AT GOLFO DE BATABANO, CUBA, Isabel Perez-Farfante	9
MIGRATIONS OF THE COMMON SHRIMP <i>Penaeus setiferus</i> ALONG THE SOUTH ATLANTIC AND NORTHERN GULF COASTS OF THE U. S., (Abstract) William W. Anderson	9
EVALUATION OF FIVE POUND PACKAGES OF GLAZED AND UNGLAZED SHRIMP, Marian Klein, L. F. Simerl, and Ernest Adams	9
COMPARISON OF OBJECTIVE TESTS FOR QUALITY OF FRESH AND FROZEN GULF SHRIMP, E. A. Fieger & J. J. Friloux	10
THE USE OF ULTRAVIOLET ("BLACK") LIGHT FOR DETERMINING QUALITY IN ICED SHRIMP	11
Charles E. Lane & B. Edward Whittaker	
FURTHER EXPERIMENTS IN HOLDING OF FRESH SHRIMP IN REFRIGERATED SEAWATER & ICE	11
J. B. Higman, C. P. Idyll, and James Thompson	
FREEZING GULF OF MEXICO SHRIMP AT SEA, John Dassow	12
DISCUSSION, TECHNICAL SESSION	13

ACKNOWLEDGEMENTS

The Gulf and Caribbean Fisheries Institute exists to serve the fishing industries — sport and commercial — by providing an opportunity for the interchange of information. Without this, much valuable data of biological, technological and economic nature is unavailable to the industry and the work of scientists is lost. It is particularly fitting, therefore, that the Institute could be partially financed by the fishing industry. The following organizations, firms and individuals contributed to the cost of printing these Proceedings, and their assistance is gratefully acknowledged:

L. C. Ringhaver, Pres., Diesel Engine Sales, Inc., St. Augustine, Fla.; Crosby Field, Pres., Flakice Corp., 360 Furman St., Brooklyn 1, N. Y.; W. E. Gallacher, Pres., Detroit Waste Works, Inc., 7340 Central Ave., Detroit 10, Mich.; John H. Rosenberg, Florida Fishermen's Supply Co., Tampa 1, Fla.; R. D. Hall, Jr., Gibbs Corp., Jacksonville 1, Fla.; J. Roy Duggan, Sea Pak Corp., St. Simons Island, Ga.; Max Swartz, East Coast Fisheries, Miami, Fla.; Ewing Lawrence, Jr., Electronics, Inc., Jacksonville, Fla.; Maitland Adams, Thompson Enterprises, Key West, Fla.; Atlantic States Marine Fisheries Commission.

MONDAY—NOVEMBER 16

Opening Address

A. J. WEGMANN

President, Bagille's Seafood Co., Inc., New Orleans, La.

It is indeed pleasing to me to attend another annual meeting of the Gulf and Caribbean Fisheries Institute. I have been privileged to attend five consecutive meetings. Each year I have marveled at the growth and importance of these meetings. Each year I have gained knowledge of our industry and the problems confronting it. I have become more impressed with that knowledge gained and to look forward to the next session. The many new friends made each year and the renewal of old acquaintances will always remain most pleasant memories to be cherished throughout life. I now look forward to the coming years of these meetings, which inspire me and give me courage to carry on. To quote from Lord Chesterfield:

"Knowledge is a comfortable and necessary retreat and shelter for us in advanced age; and if we do not plant it while young, it will give us no shade when we grow old."

During this session, you will hear many papers which will unfold to you scientific facts, backed by practical experience. The qualified persons giving these papers are doing so after many hours of study and difficult research so that you may have a more thorough understanding of the problems confronting the fisheries industry. Many secrets of the sea will be laid bare before you and as they are unfolded you can gain much knowledge. There are vast resources of marine life within the sea still undiscovered that are both essential and beneficial to mankind. Man will become more and more dependent on these resources for subsistence.

In the sessions of past years many excellent ideas were advanced and many problems were discussed. Some of these ideas have materialized into successful operations, some of the problems have been solved. However, all too few have been carried out to their conclusion. We, here, should determine to carry on after this session is ended and put them into operation. Here, let me quote from Thomas Jefferson:

"He who receives an idea from me, receives instruction himself without lessening mine; as he who lights a taper at mine receives light without darkening me."

We are indeed pleased to welcome the Food and Agriculture Organization of the U. N. which is holding the second of two International Fishing Boat Congresses here. The first was in Paris, France, in October. World famous experts in all aspects of fishing boats are here to help in the improvement of boats.

The Shrimp Association of the Americas, the Southeastern Fisheries

Association, and the Atlantic States Marine Fisheries Commission are holding meetings during the week. All of these emphasize the relatively new spirit of cooperation between our coastal states and between the United States of America and other countries.

Since the last meeting of the Gulf and Caribbean Fisheries Institute, the Marine Laboratory of the University of Miami has built the first unit of an ocean side laboratory. It is on Virginia Key, on the Rickenbacker Causeway. This is the first step in a long range plan to build a first class plant for marine research.

Of great significance is the formation this month of the Oceanographic Institute, a non profit organization dedicated to support oceanographic research. It plans to build a modern public aquarium, the profits derived therefrom will go to the Oceanographic Institute.

TUESDAY—NOVEMBER 17

Chairman—LAWRENCE W. STRASBURGER, *Food Technologist & Consultant*,
New Orleans, La.

Handling Shrimp Aboard Fishing Vessels and At the Dock

PEDRO PINSON

Refrigeradora del Noroeste Mazatlan, Sinaloa, Mexico

The procedures described in this paper refer exclusively to the handling of shrimp boats operating from the Mexican Pacific Coast, and especially to those operating from the port of Mazatlan. In order to understand the operations of such shrimp boats it would be helpful to know something of the region and of certain characteristics of the fishing there. On the Mexican Pacific Coast the shrimp season starts on October 1st and ends between July 1st and July 15th. The shrimp grounds are located at distances between 100 and 600 miles from the home port of fishing vessels. The average fishing trip is from 10 to 12 days duration. During the months of October, June and July, the average temperature goes as high as 90 to 95° F., with relative humidity readings almost as high. During the balance of the season the average temperature is about 70° F. The surface water temperature during the same months of October, June and July, averages 80° F., and during the balance of the season an average of about 65° F. This aspect is of great importance because of its direct relation with the icing of the shrimp on the boats.

The boats have an average size of between 55 to 65 feet, are Diesel powered, and are either of the regular shrimp trawler design, or are purse seiners adapted to shrimp fishing. They carry between 20 and 30 tons of crushed ice, in cork-insulated holds. The nets used (about 90 feet long on the average) are of the regular "flat" Texas design. These have been in use for the past two years, replacing the Japanese designed wing-type net with which our industry operated for almost 10 years. The other boards are about 100 feet long. Winches are the regular "Strousburg" type, and all the boats are radio-telephone equipped.

Only lately have the boats begun to be equipped with depth recorders. Fishing is done at depths between 5 and 15 fathoms. Some fishing has been done as deep as 50 fathoms, mostly for brown shrimp.

The average crew is of eight men, composed of a captain, machinist, cook, and five fishermen. The cook also works as a fisherman when not facing his stove. The reason for such a large crew in comparison with the number of men manning the boats in the United States fishery is an official Mexican regulation but also is required to handle the large catches, as we shall see later.

Before beginning a description of the actual handling of the shrimp on board the boats, two facts of interest are mentioned: (1) The boats in Mazatlan are disinfected (for rats, cockroaches, etc.) some two or three weeks before each season starts, the holds being thoroughly washed with

detergents and fresh water after the disinfection. This disinfection includes not only the holds, but the cabins, galley and engine room. (2) In our own company's boats we have been using purified ice, made with filtered and chlorinated water. It may be only an impression on our part, but "black spot" seems to have diminished on our shrimp since we started using such purified ice. Of course, the ice produced by other plants, and made directly from city water, is not polluted since Mazatlan, Guaymas, and other cities have purifying installations in their water systems. What we do in reality is to treat the water twice, for better results.

The most interesting characteristic of this operation, in connection with the actual handling, is that all the shrimp are beheaded on board the boats. This is one of the principal reasons for such a large crew. Many hands are required to behead two or three tons of shrimp per 10-15 day trip, in the shortest possible time. This practice of beheading shrimp on the fishing grounds is one which causes concern. Because of the length of trips it would be dangerous to hold the shrimp with heads on, since they spoil faster in this state. Yet the throwing of the heads back into the ocean, usually on the shrimp grounds, is considered harmful for the development and conservation of the fishery. While some of the shrimp heads are eaten by fish, instances have been noticed when shrimp have apparently left an area because of the heads thrown back. After a few days all that the nets picked up were shrimp heads, in a decomposed state. In such locations shrimp have never again been found in large volume. Various solutions have been suggested, one of them being to unload the heads onto a floating reduction plant. So far no suggestion has proved to be economically feasible.

The actual process of handling the shrimp has six main aspects. 1. The bag of the net is opened and the contents are spilled onto the deck. This should be done at a height of no more than two feet to avoid damaging the shrimp. On steel boats, because of the high prevailing temperatures and the hardness of the deck, it has been found necessary to cover the deck either with lumber or cement. Cement has proven to be much more durable and effective than lumber. Once the bag has been unloaded its contents are washed in salt water with pressure hoses. Immediately afterwards all inedible fish and other kinds of marine life caught in the net are separated from the shrimp and thrown back into the ocean. 2. The shrimp, now separated from the rest of the catch, are again washed with a pressure hose. 3. The beheading process is begun immediately after the second washing. After the heads have been taken off the shrimp are placed in 100 pound wooden boxes, mixed with a small amount of crushed ice. The men use canvas gloves on top of rubber gloves for the beheading. These gloves last only a short time, several dozen being used on every trip. 4. Once the shrimp has been beheaded it is removed from the wooden boxes and placed in straw baskets which are half filled. In these baskets the shrimp are again washed with a pressure hose, more thoroughly than the two previous times. They are now ready to go into the hold, being first placed back in the wooden boxes. 5. These wooden boxes are now lowered into the hold. The shrimp remain in the boxes until one half a ton or more has been collected. At that time the shrimp are taken out of the boxes and placed in the bunkers, mixed with the ice. A layer of ice is alternated with a layer of shrimp, care being taken that the bottom layer is never less than six inches deep. This thickness is

efficient if the hold is well insulated; on boats with deficient insulation the bottom layer of ice should be considerably thicker. 6. From time to time, especially during the last part of the trip, the first loaded bunkers are turned out and re-iced. This is done with perforated shovels. These cause some leakage of the shrimp even if handled carefully. As soon as the boat docks the shrimp are taken out of the bunkers with the same shovels and placed in straw baskets. Outside the holds they are loaded into wooden boxes and trucked to the freezing plants. In all of these movements, of course, the shrimp are mixed with ice from the bunkers. The wooden boxes are generally steam-washed after use.

Handling Shrimp In the Packing and Freezing Plant

L. W. STRASBURGER

Food Technologist and Consultant, New Orleans, La.

In order to present a bird's eye view of the general procedure in a shrimp freezing plant, the passage of the shrimp from the boat or truck will be traced through various procedures to the refrigerated truck or railway car in which it leaves the plant in its frozen form.

Briefly, the steps in the freezing process are as follows: 1. unloading, 2. washing, 3. quality grading, 4. heading, 5. size grading, 6. packing, 7. freezing, 8. glazing, 9. mastering, 10. storage.

Care must be exercised in *unloading* the boats or conveyances which bring raw material to the packing plants, to prevent breakage of the shrimp and to keep separate for close inspection, or discard, any material which appears decomposed. Where "pockets" of decomposed shrimp are mixed with good material the sorting job becomes increasingly more difficult.

In *washing*, most plants utilize either tanks from which the shrimp are tumbled, or a combination tank and conveyor belt. If insufficient attention is paid to frequent changes of water in the wash tank, the water becomes a slimy mass which adds to the bacterial load of the shrimp. A constant intake and overflow helps alleviate this situation.

Quality grading begins with a careful scrutiny of the raw material received at the plant. If this job is carelessly done it will result in decomposed material getting into the pack.

For practical purposes there are three types of decomposition which occur in shrimp, and this material should be discarded on the inspection belt:

(a) "Heated" shrimp which can usually be detected instantly. In the white and brown varieties such decomposition may be easily distinguished by color changes, but in the pink shrimp it is much more difficult to see.

(b) Blackening or melanosis, often called "ice burn."

(c) "Stinkers," or shrimp which show no visual signs of decomposition, but which possess a foul and oftentimes putrid odor of decomposition.

Heading must be done manually, and in this operation care should be exercised to prevent breakage of the tail section while removing all of the pleurothorax and the walking legs.

In a number of plants, especially in the United States, *size grading* is

accomplished by mechanical means. To the writer's knowledge there are four makes of mechanical graders on the market. In a large number of U. S. custom-packing plants there is no size grading. In Mexico and in a number of plants in this country, shrimp are graded manually for size. This art reaches a much higher stage of perfection in Mexico than it does in the United States, mainly because of a greater abundance of labor.

In the majority of plants on the West Coast of Mexico the same girls who grade the shrimp for size also *pack* them in layers into metal containers which are subsequently filled with water and then placed in the freezer. In the United States the shrimp are "jumble packed" by hand into paper board cartons, weighed, and (if in small containers) overwrapped. The "put-in weights" must be varied according to the species of shrimp which is being frozen. Apparently there is a greater freezer loss on pink shrimp than there is on brown and white, and a slightly smaller loss on white than there is on brown. Whether this loss is a true freezer loss, or is a "drip" loss, which occurs after freezing and thawing, is not clear.

Freezing methods are quite variable throughout the industry. Among principle freezing methods are the Contact Plate method and the Blast System (of which there are a number of variants). Varying temperatures are employed, depending on the system in use, from plus 20°F. to minus 45°F.

In the contact plate method the length of freezing time is dependent upon the temperature of the refrigerant and the initial temperature of the product being frozen. This does not necessarily hold true in the blast method, since the freezing time is dependent upon the initial temperature of the product, the amount of the load, the temperature of the refrigerant, the amount and speed of the air circulated, and the amount of coil space.

Care must be exercised to be certain that the individual package has reached a temperature of zero degrees F. at the center before removal for glazing and storage. Samples of slow frozen shrimp have been seen in which the shrimp in the outer portion of the package were hard, but the shrimp in the center had not become frozen and had decomposed.

The majority of the shrimp produced in the United States and on the Gulf Coast of Mexico are frozen in five-pound containers, which are not overwrapped. There is a definite trend towards overwrapping these cartons, since this procedure has been so successful with the consumer-size packages.

In order to prevent dehydration it is necessary that frozen shrimp be glazed before storage. There are several methods of *glazing* employed today. The most popular method of glazing, and the one which I consider the poorest, is the spray method. In this the opened cartons of shrimp are run under a spray of either tap water or chilled water, and the boxes are immediately inverted. Most of the water runs out, a film of ice merely forming over the top of the carton. The boxes, immediately after inversion, are placed in the master cartons, resulting in "wet masters." These quite often freeze together in the storage room or "sweat" when removed from storage and subsequently freeze together in transit. This results in damaged and torn masters, and causes a loss and breakage in the cartons in transit and in the storehouses.

A second method of glazing is the immersion of the cartons of shrimp in a vat, wetting the entire carton and causing them to stick together in the master cartons. A third system involves the flooding of the five-pound

arton with ice water, allowing a complete glaze to form around each individual shrimp, then draining and packing the cartons into masters.

Shrimp should never be glazed nor packed into masters until the center of each package has reached zero degrees fahrenheit. Glazing should only be done with ice water. These points cannot be too greatly emphasized.

The plants on the West Coast of Mexico, which in the main use the in-freezing system, drop the pans into ice water for removal of the block shrimp and frozen water, and place the entire block in a cardboard carton for shipment. Breaking out the shrimp in ice water effectively coats any exposed shrimp with a glaze.

One of the main sources of damage to frozen shrimp which occurs during storage is the dehydration of the product. In storage plants which use blast stems the product tends to dehydrate with greater rapidity than in plants which low temperatures are maintained in still air. Further, one of the fastest causes of dehydration is caused by "split," meaning the differential temperature between the refrigerant and the storage room. Dehydration will be kept to a minimum if a split of no more than seven or eight degrees is maintained.

Finally, a brief word about the important subject of *sanitation* is necessary in any discussion of handling shrimp in the packing and freezing plant.

Care should be exercised to assure an unpolluted supply of water; plants should be adequately screened to protect the product from flies and other insects. Sanitary facilities should be available for all plant personnel. Hand washing facilities with liquid soap and paper towels should be supplied, and a chlorine bath for the hands would be valuable. Plant equipment should be thoroughly washed down before and after each use, and sanitized. Refuse should be properly disposed of, and not allowed to accumulate on the premises.

Lack of plant sanitation can destroy the effectiveness of quality control; sanitation and quality control go hand in hand in the most successful shrimp freezing plants. And finally, a word of caution to producers: freezing cannot enhance the quality of your product. Only by scrupulous attention to quality grading and control, and by control in the various points in processing, as well as in the sanitation of the plant, can a first class product be sent out which, year in and year out, will bring repeat business.

Handling Shrimp in the Breeding Plant

J. ROY DUGGAN

Vice-President, SeaPak Corporation, St. Simons Island, Ga.

Since its inception just five years ago the breaded shrimp industry has become a multi-million dollar segment of the seafood business. This continuous expansion has been very similar to the amazing growth of frozen crustacean concentrates. In both fields, the young but dynamic frozen foods industry has made these products available to the mass consumer market.

At present there must be well over a hundred different brands of breaded shrimp, and even though no accurate statistics are available, it has been

estimated that from 25 to 40 per cent of all shrimp production is now going through the breeding plants. It is predicted that this ratio of shrimp used for primary processing will continue to increase. This has meant increased business—a "plus" market—for the shrimp industry. More than 200,000 frozen foods cabinets in retail grocery stores are regularly stocked with breaded shrimp. Millions of consumers have discovered the taste quality and the quick convenience of this delicious seafood. The net effect has been a constant rise in the overall demand for shrimp, and the pressure of this demand has accelerated the need for more production of fresh shrimp. The difference in supplies available and the current market requirements has caused the commodity value of shrimp on the waterfront to rise to high levels than ever prevailed prior to 1953.

During these first years of our industry we have experienced consumer approval and market acceptance which in turn has made possible the rapid growth. On the other hand, the demand factor on a national basis has caused sharp increases in fresh shrimp prices; there has been keen competition by new processors for established trade outlets, and some other protein foods have declined in price. The fundamental premise of demand, however, is that the consumer did accept breaded shrimp, and that this acceptability was built on a quality factor.

Undoubtedly the present high raw shrimp prices could be drastically cut if the major producers of breaded shrimp suddenly flooded the market with inferior packs and destroyed much of the new consumer following, in turn lowering their need for large quantities for processing. The other route to market suicide was experienced early in 1953 when short supply caused unrealistically high prices, loss of sales to other foods, and losses by the processors who could not pass along all of the increase—or who couldn't find buyers for two-thirds breeding and one-third shrimp.

It is not the intention here to discuss the broad economics of the total shrimp industry, but to describe briefly methods of handling shrimp in the processing plant in order to obtain a high quality product acceptable to the millions of families who constitute one vast consumer panel. However, since quality is inter-related to processing costs and selling prices, the plant operation is a most vital step from the ocean to the consumer's table. In determining processing policy the packer today must select one of two courses: How good a product, or how low a selling price? He cannot have both.

One partial answer to constantly increasing costs versus keen competition for markets has been found in plant mechanization. At the outset it was assumed that machinery would be developed to replace some of the hand labor of grading, cleaning, and breeding shrimp, but no large manufacturer of food processing equipment showed any interest in developing such equipment. The result was that various packers created and built their own equipment, generally based on their own ideas and experience. Today, however, there is definite interest by some machinery manufacturers in carrying forward this work and improving the efficiency of production in shrimp breeding plants.

In this phase of our development we felt that it was mandatory for the machine to deliver as good or better a product than the quality possible by expensive hand labor. Shrimp quality begins at sea. Before it ever reaches the breeding plant the shrimp must be properly handled on the boat, through

the packing houses, and during transportation as fresh iced seafood. A great deal of attention has been focused on these phases by the Shrimp Association of the Americas, the Marine Laboratory of the University of Miami, the processors, and others. Many plants like our own have found that having expert company buyers, or purchasing through highly reliable packing houses where responsibility can be definitely placed, are two safe ways to obtain the necessary ocean excellence required.

In describing plant handling, the steps outlined are of necessity those used by SeaPak, but I know from personal experience that other packers are also developing new and better in-plant methods in order to obtain the best possible quality.

We have found that certain axioms should be firmly impressed on all employees, so that there is some automatic response to offset the inevitable factors of human error or carelessness. These include such slogans as "Keep It Cold!", "Be Sure It Is Right Before It Leaves Your Department!", "If You Don't Know, Ask Your Supervisor—Don't Guess!", and similar truisms.

With the arrival of fresh shrimp from the packing houses, the first step is a quick inspection of the load for icing, count and condition, before it leaves the truck. Next the boxes are unloaded on a roller conveyor from the truck, through a canvas flap opening just large enough to accommodate the box. In the receiving room the shrimp and ice are poured into a de-icing vat with a water temperature under 40 degrees F. so they will not pick up heat from the washing water. A wide LaPorte chain conveyor moves the shrimp from the vat along an inspection section, where trained workers check the quality under adequate lights. Here also are separated any broken or crushed shrimp, heads, seaweed, or other foreign matter.

From the inspection belt the shrimp go into another belt conveyor which ascends to the top of a grading machine. A vibrating grooved table feeds the shrimp into the rapidly spinning sets of grading rolls which permits them to fall through into one of six chutes, for six sizes. Narrow white neoprene rubber conveyors move the shrimp from the grader into hanging scales which accumulate one hundred pounds of shrimp. From the scales, the shrimp are re-iced with Flak-Ice, and each one hundred pound box gets a receiving tag showing the count, lot number, and date received. A tally sheet is used to check the weight received against the shipper's weight.

After washing and de-icing, inspection, grading, and weighing, the shrimp are ready for immediate processing or holding in a cooler where the ice is allowed to melt gradually. At this point, the final end product is determined. This might be round or butterfly breaded shrimp, individually frozen peeled and deveined shrimp, cooked shrimp, or frozen shrimp. A batch number is assigned to each lot, and this batch record follows through all processing stages.

In the "Green Room" the shrimp are peeled and deveined by hand. From a table-height container holding approximately 200 pounds of shrimp, aluminum pans are loaded with about four pounds of shrimp packed with ice. These move down a conveyor to the worker's station, where the peeler places the pan over a galvanized trough of running water. The peeled shrimp fall into an empty second pan and when all the shrimp are peeled and deveined from the first pan, the peeler places her numbered plastic tag on top and sends the pan down for inspection and weighing. The weight and the employee's number are entered on a tally sheet.

At each worker's peeling station there is a continuous jet of cold running water so that the shrimp can be peeled, cleaned and washed at the same time. The small quantity sent to each worker makes it possible to keep the shrimp cold during this stage, and also facilitates easy inspection.

Once again the cleaned shrimp go back into Flak-Ice and are ready for the breading process. This is one of the most crucial phases of processing, since it is essential that the batter be kept as cold as possible to retard bacterial action. Also, it is desirable that a uniform quantity of breading be added to the shrimp—neither too much nor too little. Speed is also very important since the shrimp will pick up processing room temperature very rapidly, and the sooner the product gets into the freezer, the better.

While methods of applying breading differ in various plants, a large percentage of breaded shrimp has been improperly handled, and its quality damaged during the breading operation, primarily due to lack of temperature control in the batter or shrimp. As the temperature rises in shrimp there is a rapid increase in autolysis and bacterial decomposition which progressively destroys the value of the seafood.

After packing in the retail or institutional pack, it is imperative that the packages be moved into the freezing cycle as soon as possible. Shrimp contain about 79 per cent water, and during slow freezing much of the contained water escapes from the cells and forms ice crystals. This phenomenon is accompanied by a rupturing of cell structures, rapid autolysis, and loss of juices on defrosting. Freezing should therefore be accomplished in the shortest possible time.

Our particular solution to this problem is to freeze shrimp individually before packing, rather than packing first and freezing afterwards. Although the system is more expensive than the customary package freezing method, we believe that the end justified the means. The "end" in this case is a premium price.

As the business of breaded shrimp has constantly increased the consumer has actually become more expert in judging the quality of a particular package, based on experience either with that brand or a new brand she is trying. Before his products even reach distribution channels, the packer can make his own careful examination of the day-to-day output by having a modern test kitchen and a trained home economist. The entire annual cost of this department might be less than the direct loss in business of good will from just one hour's run of off-quality shrimp. Immediate kitchen testing will show variations from standards so that they can be immediately corrected in the plant. The same holds true with the invisible factors affecting the end product which cannot be evaluated without scientific knowledge and instruments. These include bacterial determination, examination of supplies, and the various other routine duties of the food technologist.

Efficient production by itself, even with high quality fresh shrimp, does not necessarily result in good quality. The factors of plant and employee sanitation are probably more vital to shrimp processing than any other type of food in the avoidance of contamination. Many volumes have been published on this subject, and assistance is available from local, state and federal health departments. Whenever these accepted standards are not complied with, the breaded shrimp industry is damaged in the long run for quality inevitably suffers.

After processing and freezing, the packer must maintain the finished products in continuous sub-zero storage, using a non-fluctuating temperature with sufficient air channels for cold circulation. In shipping to wholesalers storage warehouses every precaution should be taken to avoid a temperature rise at any point in the chain of distribution to the ultimate consumer.

To sum up, remember the following: 1. That quality in any shrimp product can be no better after processing than before: *buy for quality.*

That prime quality in fresh shrimp is a characteristic which is lessened each hour the product remains unfrozen, however much care is taken of the product and however small may be such change in the initial period of holding — even under ideal conditions: *complete the processing in the shortest possible time.* 3. That plenty of melting ice is essential to proper holding, no matter how low a holding temperature may be possible. Don't spare the ice and see that it melts at a satisfactory rate. 4. That cold is a protector of quality, an insulator against the normal warm air of the processing room. Surround the product with this protection through all steps of processing. 5. That the lower the temperatures can be held at all points in the processing cycle, the less harmful bacterial action there will be, and the quicker the product can be frozen when it reaches the freezer. In particular, keep batter all under fifty degrees F. in the breading step. 6. That to protect the clean-goodness characteristics of fresh shrimp, freeze it quickly. 7. That cleanliness of all equipment, pans, etc., which come into contact with the product at any stage is vital. Harmful bacteria are ever-present and will soon be out of control if not checked by adequate cleaning and sanitation methods: institute proper equipment-sanitizing methods. 8. That cleanliness of all persons handling the product is equally or even more essential than that of equipment. Have your plant personnel made aware of the importance of cleanliness in the operation. Provide for regular health checks. Provide for sterilization of hands on entry or re-entry to the processing room.

Finally, remember that consistent high quality is not easily achieved nor is the cost low, but a business and an industry can grow with quality as a partner, but not well without it. Beautiful labels, wonderful advertising programs can help mightily to sell the consumer her first package of breaded shrimp, but what quality she finds in the package will determine not only how soon she will buy another package but also if she will ever buy another package.

Handling Shrimp In the Canning Plant

H. R. ROBINSON

Vice President, Robinson Canning Co., Inc., Westwego, La.

In this country the Dunbar family began the canning of shrimp in 1867. The early problems were mainly concerned with finding a suitable container for use in preserving the shrimp. The growth of shrimp canning was aided in large measure by the advances in can manufacture and can sealing equipment. One of the first problems encountered was to prevent black discoloration caused by iron sulphide. Thanks to the development of an enamel for the interior of the cans it is no longer necessary to sew the shrimp

into cotton bags before placing them in cans, as was the case with these early pioneers.

Generally speaking, the cans and can closing equipment are the only element of shrimp canning which has reached a state of near perfection. The term "near" perfection is used, for even in this field there is a constant search for new and better enamels. For example, in recent years some discoloration of canned shrimp has been noted. The can manufacturers have now developed an entirely new enamel for use on the interior of the cans and the first commercial production using this new enamel is to be made later this month. Would that we canners had no worries other than concerned the quality of the cans, for then, indeed, we would be in a Utopian state!

However, since shrimp canning processes have not developed to such a state, it will be profitable to examine the current methods employed in canning shrimp, together with the attendant problems. There are 41 shrimp canneries in operation this year, 1953, which means that there are almost as many different ways of handling shrimp. Of necessity, this outline will have to draw heavily upon the experiences and processes of our own firm, although an attempt will be made to include all of the major variations which exist.

With canning, as with other segments of the shrimping industry, quality control begins on the fishing grounds. The initial shore operation begins with the receipt of the shrimp at the cannery. The shrimp pass through a washer and de-icer, then over an inspection belt where decomposed and discolored shrimp, as well as extraneous matter, are removed. It is probable that the visual methods of inspection will always be with us, though most producers would welcome any method which would improve detection and elimination of shrimp not suitable for use.

Following this inspection comes the weighing of the shrimp. While some firms assume ownership on the fishing grounds, our firm does not do so until the shrimp have been inspected. To our way of thinking this puts the burden of maintaining the quality of the raw shrimp squarely on the shoulders of the fisherman, for he knows that any loss will be his.

The next step is picking, and this is accomplished either by hand labor or by mechanical methods, or by a combination of both. Picking involves the removal of the head and shell from each shrimp. The time-tested method is to peel by hand. In recent years a machine has been developed and is now in use by a large number of firms. The possible effects of the action of the mechanism upon the texture of the shrimp is still to be accurately evaluated.

The waste material resulting from the picking operation is disposed of by means of dehydration. The resulting shrimp meal, which contains as its main elements approximately 50 to 55 per cent protein, eight to nine per cent nitrogen, and 10 to 11 per cent ammonia, is used either in feed manufacture or as fertilizer. The waste material salvaged from mechanical picking does not have the same composition as the waste from hand picking, for some of the elements are literally washed down the drain. A number of producers make no effort to salvage the waste material, since the cost of dehydration outweighs the commercial value of the resultant product. To our knowledge there has been very little work done on the by-products of shrimp.

Following picking, in our own cannery the shrimp pass over inspection belts where a final quality check of the raw shrimp is accomplished. Like producers in other branches of the shrimp industry, we canners are aware of the potentials of deveined shrimp. Consequently, subsequent to inspection

mes a grading of the shrimp in order that the larger sized shrimp may be veined before they continue their journey through the cannery. Both grading and deveining may be accomplished in one of two ways — by hand, or mechanically. Some of the machines presently in use show great promise, and as they are further perfected they will come into general use.

Up to this point all of the handling has been of raw shrimp. The main contributions of scientific research in connection with these phases of the operation will continue to consist mainly of the improvement of existing machinery or the development of new machinery, together with a determination and evaluation of the effect, if any, which the machinery has upon the shrimp.

Whether the shrimp are deveined or not, the next step in the canning procedure involves blanching — that is an initial cooking of the shrimp. Normally a boiling saline solution is used. There is no uniformity within the industry as to the length of cook or the strength of the saline solution. The blanch accomplishes three things: (1) the curling of the shrimp, (2) the extraction of water and solubles from the shrimp, and (3) the production of a pink color. The blanch is one of the most important processes in the canning operation. Slight changes in either cooking time or strength of cooking solutions have a pronounced effect upon the finished product. There is considerable room for study and improvement of this phase of the operation.

Following the blanch the shrimp are graded for size, and cooled. Cooling occurs both before and after the grading operation. The actual grading is accomplished mechanically, most firms using vibrating graders.

Now follows a careful check to insure that the shrimp are free from bits of shells and other extraneous matter. Simultaneously, the shrimp are checked for size and any shrimp not properly graded by the machine are placed in their proper group.

The packing operation comes next. Shrimp are packed by hand, each can being filled to an exact weight. Like other canned items canned shrimp must meet a drained-weight requirement which is established by a federal "Standard of Fill of Container." The weight of shrimp which must be placed in each can in order to obtain the required weight in the finished product varies according to the size of the shrimp and with the manner of blanching.

Following the packing operation the cans are conveyed towards the closing machines where the tops are sealed upon them. Prior to actually entering the closing machines a hot liquid is added to the can. Some firms, including the author, add a saline solution directly to the cans. Other firms add water and a salt tablet. Variations in the strength of this brine directly affect the weight of the finished product, as well as its texture and firmness.

The blanching, the packing and the added brine all affect the weight and quality of the final product. A change in any one of these operations will more than likely result in the necessity for compensating changes in the others. To illustrate, let us assume that we decide to change our blanch. This may be accomplished either by changing the strength of the cooking solution or by changing the length of time of cook. If we lower either one will result in less extraction of water and solubles from the shrimp. Unless there is a compensating change made elsewhere the finished product will probably be underweight. The reverse is true, for an increase of either the strength of cooking solution or the length of time of cook will result in the

finished product being overweight, due to excessive moisture extraction in the blanch. Neither consumers nor regulatory bodies would be apt to complain in the latter case, but the Profit and Loss Statement of the firm will soon reflect a complaint.

Once the cans have been sealed the next step is the actual processing, that is, sterilization through heat. The length of time of the process depends partly on the initial temperature of the product — the average temperature of the contents of the coolest cans going into the process. The liquid which is added to the can should be at a temperature not less than 200° F. The sealing of the top upon the can should take place as quickly as possible, to insure a good vacuum.

The sealed cans should move to the cookers within a reasonably short time after closure, with the maximum delay not exceeding thirty minutes. As the time lapse between closure and processing increases, the initial temperature decreases, necessitating an increase in the time of processing. It is also known that an undue delay between closure and processing will result in a loss of vacuum in the can.

The actual processing has received a great deal of scientific attention. Processing techniques are likely to receive considerable improvement in the near future.

Upon completion of the actual processing, canned shrimp should immediately be cooled. With some canned products the cooling cycle may be terminated when the temperature of the can contents is down to 110-120° F. thus permitting the remaining internal heat to dry the exterior surface of the can. This is not so with shrimp, which should be completely cooled to insure the complete termination of the cooking.

It may come as a surprise to some here to learn that as canners, we consider refrigeration as one of our most efficient tools. In our own firm we use refrigeration at two levels. It is used first as a means of regulating production within the cannery. For this purpose we employ storage facilities where the temperature is maintained at 26-28° F. Our second use of refrigeration comes in the storage of the finished product. For this purpose we maintain warehouse storage facilities where the temperature is approximately 65° F.

The entire canning operation is designed to result in the best possible marketable product. Despite our best efforts to date canned shrimp have certain limitations; they do not remain in prime condition indefinitely. With age there comes a softening, accompanied by a fading or blending of color. The occurrence of struvite crystals in canned shrimp is a problem that has yet to be solved, as is true with a number of canned seafood items.

Because of the varied problems we are constantly working to make the canned shrimp produced in each successive year better than those produced in the preceding year.

The Organization of a Quality Control Program In a Fishery Plant

W. F. HAMPTON

*Manager, Fisheries Laboratories, Birds Eye Division,
General Foods Corporation, Boston, Mass.*

Quality control is a technique used in the production of a product with two objects in mind: one is to keep the product out in front in the race for

the consumer's dollar, the other is to keep errors, waste and inefficiency at a minimum in the production process. There will be no disagreement over the fact that competition today makes the race for the consumer's dollar a keen one. It is equally certain that all fish producers are very much interested in any technique which will improve plant operations when such improvement is reflected in lower production costs. Quality control can go a long way toward helping achieve these aims, and consequently it deserves our closest attention. It is possible to go even further, and venture the opinion that any production or manufacturing business today takes unnecessary chances with its future if it does not have a quality control program. In fact it is doubtful if such a business can be considered a good risk.

In some form or other all fish plants have a system of quality control functioning, even though in some it may not be formally organized as a finite department. Some companies have really effective quality control departments. For all such groups, the comments in this paper may be useful from the point of view of comparison and evaluation. For those who have no quality control program, perhaps the points made will prove sufficiently stimulating to warrant giving the subject a closer look.

Let us first define what is meant by "quality" and "quality control". Most men in the trade have their own ideas as to the meaning of the term quality. Many are tempted to look upon quality in fish as simply a matter of being edible or inedible. These people know, of course, that this is not strictly the right attitude. To get a true interpretation of the term, it is necessary to examine the attitude of the consumer. It really matters little what the producer may think about quality in general, and the quality of his products in particular. The really significant thing is what does Mrs. Consumer think of the subject? If she likes our products she will buy them, if she doesn't like them we can depend upon it that she won't buy them. This is the consumer attitude that determines the kind of profits a company earns, and determines whether it stays in business.

It seems to me that the consumer's concept of quality reduces simply to "degree of excellence". To the consumer a high quality product is one that has a number of attributes for which she is usually prepared to pay a little more than the regular price. A high quality product may possess superior flavor, superior texture, superior color, or it may simply be convenient to use, preparation requiring no fuss or mess. Also — and this is important — one of the criteria of excellence, as far as the consumer is concerned, is that the product must *consistently* come up to her expectations. In other words, she must be able to depend on it that every package that she buys will be the same. She will consider a product to be of poorer quality the more it fails to meet these desirable attributes and come up to her expectations in every package.

The term "quality control" is simple to define. It is merely the technique or the tool that the management of a company uses to achieve the degree of excellence desired in its products. There is nothing complicated about the quality control function, any more than there is anything complicated about the accounting or bookkeeping function. The accounting department keeps the score on the dollars, the quality control department keeps the score on the product.

Quality control is simple and straightforward, both to establish and to manage. However, it does require a little time and some patience, and it is

probably desirable in the beginning, when a program is first being established to obtain help from some one who understands the mechanics of quality control.

The quality control program can be made simple or complex, depending upon the extent of the job that is to be done. A program to cover a fresh fish business might, for example, be fairly simple. On the other hand, a program designed for breaded shrimp or canned shrimp might be considerably more elaborate, while one for precooked frozen shrimp might be more elaborate still.

What does the quality control program consist of, and how is it established and operated? There are certain steps that must be taken and these are now described.

First, product standards and specifications must be established. Settling such questions becomes a matter for management, including production, sales and quality control, to decide. Next, procedures and specifications must be worked out covering the method of making the product. Obviously, these must be designed so that the product specifications can be satisfied. Next comes a system of operating controls and checks which are designed to keep watch on the operation. Finally a system of reporting and follow-up must be established.

Product Specifications

Product specifications are a fundamental part of the quality control program. The program cannot exist without them. They provide the standards which the production department must meet. Obviously, there will be some degree of deviation from the standards since no production department will always be completely successful. Product specifications, therefore, should be regarded as targets to be aimed at. It is the job of the production and quality control departments to work together to keep the score as high as possible. Usually specifications include tolerances to provide for variability in actual production.

The specifications should cover all aspects of the product as completely as possible. Ordinarily the attributes to be defined are flavor, texture, odor, color, size, net weight, number of pieces per package, and ingredients. Obviously, different products will have different specifications, but the general pattern is the same.

The selection of specifications must be given careful study, and is a matter for company management to decide. Samples which may serve as reference material for the selection of specifications may be from past production that was particularly successful, an experimental sample from the laboratory, or from the kitchen. Again, a sample of a competitor's product might serve as a reference standard.

The sales department must have a share in setting specifications, because sales personnel are the best informed group as to the product which will sell best. At the same time the production department must participate, since the product specifications finally selected must fall within the realm of practicality, and must be capable of production with available facilities. In the final result the two departments must concur. The production department must agree that the specifications selected are within their power to produce, the sales department must agree that the specifications represent the product they want to sell, and which they expect consistently to get from the production department.

It is a good idea to reduce specifications to writing. This helps to avoid confusion and misunderstanding in case a difficulty arises. The best method of doing this is to prepare an Operating Manual which covers all product and process specifications, quality control procedures and checks. This manual should be just as complete with detail as it can be made. One such manual in our organization comprises a loose-leaf book of closely typewritten pages over an inch thick.

Process Specifications

Obviously, any haphazard process will not successfully and consistently produce the product for which specifications have now been written. It can readily be seen that there must be certain limitations to the process. By the preparation of process specifications these limitations can be defined to give the production department a procedure which can be expected to be successful practically all the time. These specifications then become part of the quality control program.

The process specifications should define the process as completely as possible, and it should indicate the degree of variation that is permissible at various stages in the operation. These variations are "working tolerances". In the case of the product specifications, they should be reduced to writing, and should form part of the Operating Manual. This kind of information constitutes the so-called "know-how" of the company.

Process specifications should include an accurate description of the raw material used, and the manner in which it should be handled. For a shrimp product, for example, a specification might be written requiring that the flavor and color of the raw material to be used should possess certain characteristics. They might also state that in order to satisfy this requirement, the shrimp should have been well packed in ice for a period not exceeding a given number of days prior to processing.

In this connection the work carried on by Dr. Fieger and his associates at Louisiana State University is valuable. Their experiments have shown that palatability and flavor of fresh shrimp decreases slowly during the first five days of storage in ice, and disappears by the eighth day. From this point on the shrimp are characterized over a period of some seven days by a flat taste, or are actually tasteless. During this period, however, none of the off-flavors ordinarily associated with spoilage were noted. The scientists found that in this latter stage the cooked shrimp had lost the opaque white appearance which is characteristic of fresh shrimp, and had taken on a faint bluish translucent appearance. At the end of this second seven-day period, off-flavors became evident and in the opinion of the research group, the shrimp were inedible.

This kind of information is the most valuable that can be obtained for the purpose of writing raw material specifications. It can readily be seen how the method of handling the raw material, and the time of storage, affects the color and flavor of the final product. In our frozen fillet business we have carried out a similar type of study, and written specifications for our product based upon a similar type of information.

The steps in the process obviously vary with the product to be packed. If it is a canned product, then the specifications must include method of obtaining the vacuum, hot fill or cold fill, minimum temperature for loading retorts,

process temperature and pressure, process time, etc. A frozen product will have a similar set of specifications. For a new product all these details must be worked out. For an established product, the experience and "know-how" of the operating personnel may be sufficient to supply the desired data.

One important phase of the whole program in the processing area is the training of operating personnel. The human element is always a question mark on a production line. The end product depends a great deal on how well each man on the line does his own particular job. It is reasonable, therefore, that time taken to explain carefully to each man his share of responsibility, and his duties, will be well spent. Failure on the part of an employee to carry out his job properly can spell failure for the product. Each employee can be expected to do his job adequately and properly only if he has been trained for it, and if he has an intelligent understanding of it.

Operating checks

Having now settled the specifications for the product, and also for the process by which it is to be made, the next step is to install a system of checks on the actual performance. These consist of checks on the product as it comes from the line, and also checks at various key points in the production operation.

Samples of the product coming from the line should be examined at staggered intervals throughout the production period. The results are arranged alongside the product specifications, and a judgment then made as to whether the product is satisfactory or not. In the event that the results indicate a deviation from specifications, an examination of the production line is made at once to determine the possible cause. The testing procedures may include physical examination or microbiological examination, as well as subjective tests for taste, texture, odor, etc. In some companies it is common practice for the management of the company to participate in these tests, and a specified time is often set aside for them each day.

A recorder chart attached to a retort in a canning operation provides an excellent example of a check made on the performance of a given step in the production line. On this chart will be recorded the process time and temperature for each batch. Other line checks in a cannery operation may consist of precook temperatures, brine strengths, sealing machine performance, etc. Raw materials frequently are continually under observation by operating personnel at the receiving end of the line. Independent checks may also be made at intervals by quality control personnel.

Depending upon the type of operation, the amount of line checking to be done in a fish plant may be quite limited. In the production of frozen fillets, one might have raw material checks, checks for presence of bone, blemishes, or parasites, brine strengths and pick-up, freezing time and temperature, etc. Every process will have its own particular key points at which checks should be made.

Reports and Follow-up

This consists of arranging all the test data obtained on the product and on the lines in report form for submission to the front office. When the need for action is indicated in these reports, it is better to place the responsibility for this directly with the production department, or with the management of the company. In this way the function of the quality control department

comes one of making the necessary inspections, according to a pre-arranged plan, and reporting these to the proper authority in the plant for necessary action. It is usually the practice that quality control does not have the authority to make changes in the production procedure. This is left entirely to the management of the production department. Quality control should, of course, offer every assistance in attempting to resolve a difficulty without undue delays. For example, if the quality control finds something wrong along the production line, its first duty is to advise the production manager or supervisor without delay, so that corrective action can be taken without danger of lost production.

Conclusion

Quality control is frequently regarded as consisting of a laboratory in which a man with a white coat does "bug counts", and makes other mysterious tests. The quality control manager is frequently recorded as a thoroughly unsympathetic detective who is always looking for trouble, and frequently punishing it. These concepts are totally wrong. Quality control is a method of operation, a method of management, a method of thinking, such that production errors and risks may be reduced to a minimum. A quality control department is simply a part of that system. The quality control manager is not an unsympathetic detective, but rather a helpful constable.

A real quality control system involves a great deal more than a laboratory, a man, and a microscope. It involves an understanding of how the system works, an active and sympathetic participation by the management of the company itself.

Quality control is a useful function that can pay dividends. It requires setting high standards on the product to be produced, and determination to produce it that way. A company deciding to make use of a quality control program should first consult with some one experienced in the matter. Obviously, each operation must be worked out separately, and each may require different specifications and procedures. It is important to select the right personnel, and to obtain the full support of management.

DISCUSSION

Industry Section

Discussion Leader: W. F. HAMPTON

Discussion Panel: MANUEL SANCHEZ, HARRY F. SAHLMAN,

E. A. FIEGER, HARDEN TAYLOR

Q Hampton: How many shrimp are left on deck after a drag in the West Coast Mexican fishery?

A Pinson: Up to 2000 pounds, although the average drag (1½ to 2 hours) would yield 200 to 250 pounds.

Q Hampton: What precautions are taken, if a large catch is made, to protect the shrimp while on the deck?

A Pinson: Ice is shoveled over the shrimp and mixed thoroughly.

Q Fieger: Do you place ice on bottom and top?

A Pinson: Yes.

- Q. Mingledorff: What is the longest time the shrimp are kept on ice aboard the boats?
- A. Pinson: Ten to 12 days at sea, with two days spent in travel to and from the grounds. The oldest shrimp are ten days old on reaching the dock.
- Q. Weil: What was bacterial count two to three days after capture?
- A. Fieger: The bacterial count depends upon the position of the shrimp in the hold, with the top layers having less than 1,000,000 after 10 days and the lower layers about 100,000,000 per gram after ten days. After capture the bacterial count runs 500-40,000 per gram. After washing average count would be about 7000 per gram.
- Q. O'Neill: Are there any future plans for freezing shrimp at sea on Mexican west coast?
- A. Pinson: They have five freezer boats at present but their operation has not proven economically feasible so far.
- Q. Levenson: What is a dangerously high bacterial count and what are the types of bacteria involved.
- A. Fieger: 25,000,000 per gram and above is considered prohibitive. *E. coli* an indication of human contamination is considered dangerous.
- Q. Levenson: Can these counts be kept down?
- A. Fieger: Use of germicides would be all right if Food and Drug would accept them. One per cent sodium bisulphite in saline solution reduces bacterial count.
- A. McPhillips: Our boats are cleaned carefully after each trip with live, wet steam for 15-20 minutes.
- Strasburger: Chlorine is better than live steam if used after a thorough wash down of the hold.
- Malton: One to 200 ppm chlorine is used in butter churns in dairy plants.
- Pinson: Our holds are covered with galvanized iron; no wood is exposed to the shrimp.
- Sahlman: Plastering of the hold is a good practice.
- Pinson: I think not. Cracks may appear and bacteria may enter there.
- Strasburger: A solution of 200 ppm of chlorine is sufficient. Metal lining is superior to either cement or wood, which are porous and harbor bacteria.
- Q. Fieger: What size of shrimp are landed in the Mexican fishery?
- A. Pinson: About 75 per cent of the catch is under 15 count. In the spring they may run 36-43 count.
- Q. Wegmann: How long does heading process take and what protection is afforded from the sun?
- A. Pinson: About one half hour. Canvas is used overhead as protection for the shrimp.
- Q. Colter: How can the producer determine bacterial count of shrimp?
- A. Fieger: There is no method at present that can be used on the dock. Spoilage is determined only by the appearance of the shrimp.

- Idyll: How do you think the tossing of heads overboard affects fishing?
- Pinson: In a confined area the throwing of heads overboard can cause the shrimp to leave the grounds. Also, boats sometimes pick up large quantities of partly decomposed heads in the net.
- Strasburger: Yet some people suggest chumming for shrimp with shrimp meal so that catches can be improved.
- Ferreira: It is illegal to discard heads and other trash from shrimp boats but the law is not enforced at present. American biologists claim the dumping of heads on the grounds is not harmful. I personally believe that this practice can be harmful in certain cases.
- Ellison: In Pamlico Sound the dumping of trash has not affected the catches of shrimp.
- H. Taylor: I suggest experiments along this line. Feeding habits, observed in aquaria, would be helpful.
- Duggan: Disposal of heads is always a problem to processors. I suggest the use of a grinder of the type used in kitchen disposal units.
- Strasburger: In our plants in Cleveland and Dallas we grind the waste and flush it into city sewers.
- Wegmann: The dumping of heads causes pollution. The solution is to dump the trash over a wider area.
- Strasburger: Are not metal baskets more sanitary for use on board the boats?
- Pinson: Wooden baskets are cheaper but require replacement after several trips.
- Sahlman: Are any attempts made to ship in shrimp after several days to allow fresher shrimp to reach the dock?
- Pinson: No, this has not been attempted in Mexico.
- Sahlman: The American Campeche fishery does this. We find this technique improves the quality, with no shrimp more than six days old being landed on the Florida west coast.
- Ellison: What causes the so-called "stinker" shrimp?
- Strasburger: No bacteriological work has been done on stinkers but they are found in conjunction with decomposition.
- H. Taylor: Are these stinkers related to the so-called "carbolic" shrimp?
- Strasburger: No, the stinker is caused by decomposition and the carbolic shrimp is caused by iodoform. The latter are often associated with waters of high salinity.
- Sahlman: Are there any iodoform shrimp in the Campeche catches?
- Strasburger: They are found in brown shrimp, *Penaeus aztecus*, of U.S. coast in June and July especially, and in white shrimp, *P. setiferus*, from Mississippi delta and west to Freeport, Texas. They are not as prevalent in Florida east coast catches.
- Sahlman: Has the iodoform other effects than smell?
- Strasburger: Yes, it affects the taste.

- Q. Ellison: Could you review the loss of weight problem during freezer storage?
- A. Strasburger: There is least freezer loss with white shrimp and greatest with the pink shrimp, the brown being intermediate.
- Q. Pinson: What are the possibilities of making a five pound package of shrimp without glaze.
- A. Strasburger: Five pound packages, not glazed but overwrapped, produce a very good product.
- Klein: A paper on this subject is being given on Friday.
- Q. Duggan: If the shrimp are frozen in pans immersed in water what is the effect of pressure during freezing?
- A. Strasburger: The metal pans are split by expansion.
- Q. O'Neill: Flavor is a function of storage time. Is there a law specifying the maximum time in freezers?
- A. Wegmann: There is a federal law which specifies that shrimp should be destroyed after one year in storage. This law is not enforced at present.
- Malton: This storage time regulation was a wartime measure.
- Q. Wegmann: What is the average weight loss in five pound pack in 12 months?
- A. Strasburger: This loss depends on many factors, such as species, storage conditions (mostly temperature), packaging methods and the type of freezer. The loss also depends on individual plant conditions.
- Hampton: Moisture loss is a direct function of storage. At lower temperature there is less moisture loss if the package is correctly wrapped.
- Q. Ferreira: What does the Food and Drug Administration say concerning labeling of a five pound package? Can you say "five pounds when packed"?
- A. Strasburger: The contents must weigh the amount stated when it is opened by the consumer.
- Pinson: We add to five pound packages three ounces of raw and six ounces of peeled shrimp to compensate for losses.
- Q. Fieger: What is the allowable amount of breading that can be added in breading shrimp?
- A. Duggan: No standard has been established as yet but industry recommendations are for: "greater than 42 count—up to 50 per cent breading; less than 42 count—up to 42½ per cent breading." Army requirements call for 29 per cent batter.
- Q. Sahlman: How much batter do you put on your shrimp?
- A. Duggan: To 100 pounds non-peeled shrimp (which produce 80 pounds peeled) we add 30 pounds of batter, to make up 115 pounds of the breaded product.
- Q. Sahlman: Would the addition of water to batter be of advantage in freezing and cooking?
- A. Duggan: This was tried and did not work well since when cooked the water comes out in the grease.
- Q. Fieger: What effect has salt and time of blanching on the yield?

- Robinson: Blanching takes three to eight minutes at 33-40° salometer reading. Cooking losses can be high.
- Jackson: What is the storage life of canned shrimp?
- Robinson: Thirty months, although we are still testing 15 year old packs. (These are not in top market condition!)
- Jackson: What preservatives do you add?
- Robinson: None.
- Wegmann: Which do you find best, truck or boat deliveries of shrimp?
- Robinson: From distant points like Apalachicola it is better to transport shrimp by truck. Catches taken directly from the boat are usually best, however.
- Wegmann: Can the consumer tell the age of a shrimp pack by looking on the can?
- Robinson: No. However, since War II production has never caught up with demand and the consumer does not need to worry about buying old shrimp.
- H. Taylor: Has a satisfactory method been found to anticipate spoilage of seafood products?
- Hampton: No method has been found as yet. Spoilage is a combination of rancidity and of decomposition of protein.

WEDNESDAY—NOVEMBER 18

Chairman—A. J. WEGMANN, President Bagille's Seafood Co., Inc.
New Orleans, La.

Financing of Fishing Vessels by Commercial Banks

CHARLES T. TAYLOR, *Assistant Vice President, Federal Reserve Bank of Atlanta, Atlanta, Ga.*

The Federal Reserve Bank of Atlanta, since it is a central bank, does not make loans to business or agriculture except under extraordinary circumstances. It is primarily a bankers' bank. As such it performs what might be called "facilitating services," including the provision of currency and coin, clearing checks, and acting as a fiscal agent for the federal government. Perhaps of even greater importance, however, is its share in the responsibility the Federal Reserve System has for managing the nation's money supply, or in the words of the Federal Reserve Act, "accommodating the needs of commerce, agriculture, and industry."

Those who manage the money supply must obviously be informed of the nature of the economy of the region served by the bank. Consequently, our interest in the fishing industry grows up out of a research program, one purpose of which is to learn more about the economic structure of the Sixth Federal Reserve District, which includes the states of Alabama, Georgia, and Florida, the southern halves of Louisiana and Mississippi, and the eastern two-thirds of Tennessee.

The writer, therefore, is only an outside observer and not in direct day-to-day contact with the actual financing of fishing vessels. Consequently, this paper will be limited to the consideration of two points: general observations about commercial bank lending policies, and observations on how commercial banks have been able to finance fishing vessels within the framework of these policies.

Although many of you have a clear conception of the structure and policies of commercial banking and how these matters affect bank lending, others often do not have this basic knowledge. The following quotation taken from a letter from a fishing-boat captain some time ago illustrates the point.

"I have been connected with the fish industry of the United States and Canada for the last 63 years in all its branches It has always been a wonder to me why the banks have not gone after this fishing industry business. I have always claimed that the security is far sounder than the farm loan is Right now there is a body of men who have the best security in the world so if you know of any banks that would be interested in loans to the fish industry I would be very much interested in going into details."

Although this particular letter applies to the fishing industry, we could all insert farming industry or practically any other than you might name. The chief complaint made about commercial bank financing is that the bankers will not make loans for long enough periods, that they will not make them in large enough amounts, and that they require that repayment be made too soon. For example, some agricultural experts want banks to make loans extending from five to ten years with no repayments to be made within two or three years. "Why," these and other persons ask, "are bankers not taking advantage of the opportunities of making such profitable loans?"

To answer this question a word about the structure of the commercial banking system is in order. Under our American system all commercial banks are privately owned and operated. Some are chartered by the national government and are called national banks. These banks must be members of the Federal Reserve System. Others chartered by the state governments may be members of the Federal Reserve System if they so desire, and if they meet certain requirements. All member banks, both national and state, must be members of the Federal Deposit Insurance Corporation, but non-member state banks also may be insured banks. Before issuing charters banks must meet certain specifications set up by law and are subject to periodic investigation by the supervisory authorities. Despite the various types of charters issued, laws, and supervision, however, there is much more uniformity in commercial banking operations than might be expected. Although bank examinations are made to insure that banks are being soundly operated, except in certain limited cases bankers themselves are the ones that determine how large a loan they will make and to whom they will lend and on what terms they make their loans. Lending policies are probably determined more by what are regarded as sound banking principles by all types of bankers than by the particular laws that might restrict them from making certain types of loans.

Bank lending policies are greatly influenced by the nature of the bank's liabilities, the overwhelming part of which are demand deposits subject to immediate withdrawal at any time. To some extent bankers can predict withdrawals: during certain periods of the year withdrawals will greatly exceed new deposits. In Miami, for example, deposits in October are likely to be about 15 per cent lower than in April. But the bankers must also be prepared for a withdrawal of deposits resulting from other factors that they cannot predict so easily. Perhaps they may lose some of them to their competitors. Perhaps a year or two from now economic conditions will cause deposits to flow out of their communities.

Unfortunately, bankers, like anyone else, are not infallible prophets, and even if they do not know exactly what will happen in the future the bankers must set up certain safeguards in their operations against unfavorable contingencies. On the basis of past experience, therefore, bankers have found it necessary to keep a large proportion of their assets in the form of secondary reserves that can be converted immediately into cash. Generally speaking, government securities are more liquid than loans, but which can be liquidated, if necessary, with little or no loss. Investment in government securities, however, would not earn the reasonable profits that are essential to a soundly operated bank. Moreover,

bankers know that their success depends to a considerable extent upon the prosperity of the communities they serve, and that this prosperity requires bank credit. They are, therefore, interested in making loans, but they must consider many factors other than the credit-worthiness of a particular loan application in making their decisions about how much credit they will grant to private industry, and on what terms they will grant it.

These considerations have led bankers to specialize in short-term rather than long-term credit. It is generally only when the demand for short-term credit is so small that normal funds cannot be properly utilized that most bankers make considerable amounts of long-term loans. Immediately after World War II, for example, bankers granted more long-term loans, probably because with ample funds available for lending and the low returns that could be secured on government securities, the slightly higher rates on long-term loans helped to bolster bank earnings. Even then, in the Sixth Federal Reserve District, long-term loans constituted only 14 per cent of commercial and industrial loans. Since then the practice of making long-term loans has apparently become less common.

Bankers also try to maintain liquidity by diversifying their loans. This means, for the smaller bank, that a bank may often have to turn down an application for a loan that apparently meets all other credit standards, merely because the banker already has made several loans to persons in the same industry. Banks in single-industry cities, such as one where fishing predominates, may often not be able to satisfy all credit demands of that industry. On the same basis, however, a bank that has no such loans might want to consider them for the diversification they would bring.

Bankers are doubtful about making loans to persons in industries that are subject to violent swings from prosperity to depression, and where success more often depends upon the vagaries of prices than upon wise and skillful management. They will, therefore, sometimes be reluctant to grant loans to persons who want to get in on "a good thing" that has enjoyed phenomenal success because of major price or demand changes, while at the same time they will grant the loan to a person in the same industry who has had experience and is in for the "long pull."

Bankers dislike making loans to persons or industries about which they do not know enough to be able to make intelligent decisions. This tendency often accounts for the concentration of loans of certain types in one bank rather than another located in the same city. Bankers must be experts to some degree on all the kinds of businesses to which they make loans. Limitations of time and personnel make it impossible for some banks to be informed on all types of industries.

Occasionally legal prohibitions may prevent the granting of specific loans. For example, a national bank cannot make a loan to a single borrower amounting to more than 10 per cent of its unimpaired capital and surplus. On the basis of this provision, smaller national banks may find it impossible to finance the larger and more expensive vessels that have become common in recent years.

Bankers that are members of the Federal Reserve System have the protection that in case of an emergency they may borrow from the Federal Reserve Banks. In recent years practically all borrowing has been secured

government obligations. However, some bankers do not like to have so large a proportion of their loans of a type that is ineligible for discount with a Federal Reserve Bank, and such ineligible loans include non-agricultural loans having maturities of over 90 days, whether to purchase vessels or for any other use. These loans, however, may be used as collateral for advances secured from a Federal Reserve Bank at a higher, or penalty discount rate.

More often, however, it is the adherence to what are considered sound banking practices that would determine the acceptability or non-acceptability of any application for credit. In this respect there may be little difference between the actions of national chartered banks, state chartered banks that are members of the Federal Reserve System, and non-member banks.

Working within this framework several commercial banks in this area have been able to make loans to the fishing industry that have been advantageous to both the borrowers and to the banks. They have been profitable to the banks, and at the same time the banks have gained indirectly by fostering the development of an important industry in their areas.

There is no record of the total amount of money that banks have outstanding to finance the fishing industry, a condition that applies to almost all types of industries as well. There is some idea, however, of the types of loans they make, based upon data collected in a survey made a few years ago of commercial and industrial loans. Data obtained from interviews and correspondence indicate that conditions at the present time are very similar to those at the time the survey was made.

Reports from banks in Florida, Georgia, Louisiana and Mississippi show that most of the credit outstanding to the fishing industry was for a period of less than one year. Only 10 per cent of the total amount of credit outstanding was extended for a period of more than one year. Apparently most of the credit granted by the banks to the fishing industry was used for short-term working capital. A similar survey made in later years would probably show an increase in the proportion of long-term credit granted, since the survey was made soon after the close of World War II and comparatively few boats were being purchased at that time. Over three-fifths of the loans outstanding were to borrowers with assets of less than \$2,000.

The most common security required by the banks was a chattel mortgage on boats or other equipment, and this applied equally to long- and short-term loans. Endorsement was required as security for about one-fifth of the loans outstanding; almost one-fifth of the loans, probably short-term loans, were secured. About three-fifths of the loans outstanding provided for payment in instalments.

In recent years bankers who have made loans for the purchase of fishing vessels have been pleased with their experience when, in the words of one banker, "the proper practices are followed." One of the most interesting things coming out of the rather limited survey is that, in attempting to arrive at methods by which financing of fishing vessels could be incorporated into what they considered sound loan programs, bankers have arrived at pretty much the same conclusions whether they are located in Georgia or Mississippi.

First of all, there are bankers who make no loans to the fishing industry at

all, even though they are located in coastal cities where fishing is important. Sometimes this results from the attitude expressed by one banker that he feared that if a depression took place there might be so many boats on the market that he would be unable to recover on his collateral. Other bankers simply have had no demands for loans, because few if any of their customers are in the business and, in general, banks prefer to make loans to their own depositors. Other bankers, probably wisely, believe that they do not have sufficient knowledge of the technicalities of the business to enable them to supervise such loans properly. Or, perhaps the demands from customers in other lines of business leave no funds available for financing fishing vessels. Some banks are unable to finance fishing vessels because of the tendency to use larger and larger boats. According to one banker, "the day of the 30 foot shrimp-boat with an automobile engine is past, and a small bank cannot, either because of legal limitations or prudence, make a loan of sufficient size to finance the purchase of a modern large vessel." However, some bankers are active in financing the purchase of vessels.

The bankers' first interest, when making loans to any type of borrower is in what they call the general credit-worthiness of the borrower, no matter what type of security may be offered for the loan. Decisions about credit-worthiness are based on a number of factors, some of them intangible. First there is the record that the operator has established, evidenced not only by his general reputation, but by financial statements, including a record of his operating results for several years. The banker, of course, will consider his record of integrity and the multitude of other factors that are always considered by loan officers. One banker states that he is reluctant to make loans to persons who do not operate the boats themselves, since success depends so much upon expert supervision. Another states that he does not like to make loans to single-boat operators. Other bankers believe that the prospective borrower should have financial worth outside the boat itself.

After having satisfied himself as to the general credit-worthiness of the borrower, the banker will probably next have to satisfy himself that a chattel mortgage on the boat will meet his requirements. Most bankers then proceed to an appraisal survey. It is here, of course, that the banker needs to have specialized knowledge. One banker relates that the knowledge required includes something about the construction of the boat, the amount and the kind of motive power required, the power generated by the electric plants, the reduction gears, and so on. He is more likely to consider the collateral favorably if the boat has more than one possible use. He will also have to satisfy himself that there are the proper documents and that sufficient marine insurance is carried.

The potential borrower from a bank must generally have a substantial equity in the vessel. Perhaps some banks will lend as much as two-thirds of the value of a new boat or 50 per cent of the depreciated value of an older vessel. Other bankers will lend no more than 50 per cent of the value of the vessel. The loan contract will generally provide for repayment either in monthly or quarterly instalments over a period of no more than three years and sometimes only two years.

Financing fishing vessels is, of course, not the only type of lending to

ch banks grant credit to the fishing industry. Many banks help provide king capital by short-term loans, either secured or unsecured, to lesalers and to packers. Although by no means the only source, mercial banks have been able to help satisfy the credit needs of the ustry.

Financing of Fishing Vessels in the Gulf States

JOHN J. FAUBION, JR.

First State Bank, Port Lavaca, Texas

s a banker I want to go on record that I like the commercial fishing ustry — every phase of it. Also, I am somewhat apologetic for the pence with which the banking fraternity has recognized this, America's st industry, as the sound bankable business that it really is.

ankers have a reputation for being somewhat cold and calculating, and ibly that is why banks have been so slow to recognize the importance he fishing industry and what it means to the nation, the community, the bank itself.

When I moved to the Texas Coast in early 1947 the commercial fishing ustry meant nothing to me. My knowledge of commercial fishing was ted to the lone little fish market in our West Texas town, and the odor t was a poor introduction to the industry. Port Lavaca, at the time I ed there, was primarily a cotton and cattle town, insofar as banking was erved. Rice was a new industry for us, and in self defense we had to out of our bank and learn something about rice. This got us in the ing habit, I suppose, for it was not long before we also made it a point pend some time out of our bank learning about another new industry — mercial fishing. It was not long before we began to notice that the cks for the seafood industry going through our bank were larger and more lar in their appearance than previously.

hen, in early 1948, a bright-eyed young man came into the bank and ed to talk about a loan to build a new shrimp trawler. Our first ulse was to turn him down flat, but we had inaugurated a new attitude rd the public in our bank, this new attitude being one of definite dliness while endeavoring to learn something about the new industries ur community. So we listened to the young man instead of dismissing ur with a flat "no".

his man's appearance, alertness, obvious educational background and gssiveness did not fit into the vague pattern we had in our mind of a mercial fisherman. After listening to him for a few minutes we were urely interested in his proposition, and asked him to return the next . This gave us a chance to evaluate what he had told us about himself about the operation of modern shrimp trawlers. What we learned, we . This not only clinched the loan for this, our first applicant, but sold n the feasibility of lending money on shrimp trawlers and to the seafood ustry in general.

ve have been financing fishing boats ever since the first contact with the ustry in early 1948. On November 12, 1953, we had outstanding

\$612,375.09 in loans on commercial shrimp trawlers. Although this is no a lot of money to the large banks, with us (a bank of about \$10,000,000 in deposits) it is about 20 per cent of our total commercial loans, and it might be interesting to you to know that since making our first boat loan in the early part of 1948, we have financed 137 shrimp boats, representing total loans of \$1,432,000, and we have not yet had to repossess a single boat.

An obvious question is — "How do you account for your luck or success, or both, in financing the 137 boats, through loans totaling nearly one and half million dollars, without having even one repossession?" And first, let me say that not every loan we have made has been perfect — we have had our share of loans we have had to nurse along, but we have always made it a point to keep in close touch with all of these loans and have tried to make it our business to spot trouble early. We feel that by keeping up with each boat regularly we have been able to avoid several situations on which we could have lost money. We require the owner of every boat that we finance to carry his bank account with our bank, thus affording us an opportunity to see all of his income and expenses. There is no better way to keep up with anybody's business than to know how much money they make and how much money they spend.

I would like to tell you our exact procedure in closing a loan on a shrimp boat. We believe firmly that in financing a fishing boat, just as in financing anything else, the first essential to a successful loan is a good man — that is, a man of character, ability and the desire to work. We try very hard to satisfy ourselves first that the man is honest, second, that he is an experienced fisherman, and third, that he has had an opportunity, through actually fishing himself, to know what he is up against. Also, we want to know that this man has the determination, energy and desire to work. There are many capable fishermen who are satisfied to make a trip that will provide them with merely enough to buy a few groceries or to have a good time, and do not care about taking the boat out again until they are out of money. It is my observation, however, that there is a steady improvement in the men who fish our boats and in those who are in the producing end of the fish business. They are getting to be better business men, and it is a good thing that they are.

After we have satisfied ourselves as to the man — his honesty, ability, and experience (and, by the way, our decision depends to a large extent on our personal impression of the applicant), we next consider the boat that the applicant either wishes to buy or to borrow against. We finance both new and used boats. One of our first requirements is that we be furnished with a recent (not over ninety days old) survey by a licensed marine surveyor of the boat that will be mortgaged to us. We use this survey, not necessarily as a guide to the actual value of the boat, but more to acquaint us with the particulars of the boat, and to call to our attention any repairs or alterations needed to put the boat in good condition. Our best guide to the sound value of the boat is its insurable value through an established insurance company. Once we are satisfied with the man applying to us and we have determined a value on his boat we customarily lend from 50 to 75 per cent of this value, and our loans run for a period of from two to three years. We have meanwhile completed all of the details on our loan, such as preparing a Preferred Customhouse Mortgage against the boat, holding insurance

covering our loan and with Loss Payable in favor of our bank and securing complete credit report file on the borrower.

We do not lend on boats of less than fifty feet in length, simply because we have found that smaller boats are not in demand. A typical shrimp boat in our bank is one that I closed just before coming over here. This boat has a steel hull of about eighty feet in length and cost \$52,000. Our customer paid \$22,000 in cash and we have financed the balance for him over a period of two years. His payments to us are made every three months, because we have found that this enables the borrower to keep up with his payments much better than if they are monthly payments. Bad weather, high winds, or other circumstances may make it impossible for a man to fish as long as two months at a time.

Without reliable insurance companies insuring shrimping vessels there would be no sound way of financing them. As a result of companies offering insurance on the boats at a reasonable rate we are now able to finance boats that we could not consider financing just a few years ago.

Obviously, our bank likes the commercial fishing industry. I am sorry that other banks, many of them are on the Gulf Coast, do not share the same enthusiasm for this business that we do, because I honestly feel that they are passing by a wonderful piece of business for their banks. There is still much need for improvement in financing the various segments of our growing seafood industry. It is not only the opportunity but the duty of banking to readjust its visions and thinking to conform to the new stature of commercial fishing.

In spite of much progress made by some banks in providing sound credit to fishing boat owners and seafood dealers in the past six or seven years, there is still no long term credit available to boat owners. And long term credit is sorely needed. It is not the job of the commercial bank to provide long term credit and actually our commercial banks cannot do it. We can make loans payable over a period as long as five years, but we do not like to. Furthermore, we are not able to do it regularly. Most of our boat loans are for a maximum of three years and a lot of them pay out in two years. As far as I know, no customer has had any serious difficulty in meeting his notes on their terms. But larger and more expensive boats are being built. As recently as three or four years ago a shrimp trawler costing \$30,000 was considered a small and modern boat. Today the average price is nearer \$50,000. If boats continue to grow in size and price it is logical to believe that, within a few years, the average shrimp trawler could cost \$100,000 or more. In the past the average shrimp boat owner who borrowed from us has paid off his notes in three years or less, from profits from the boat. It is possible to do this on a boat that cost \$30,000 or even as much as \$50,000 but a loan on a \$100,000 boat will be very difficult to retire in three years and still leave enough profits to pay income taxes.

It appears, then, that fishing boat owners must have some source of long term credit. Commercial banks cannot provide it, but I do believe the industry has stabilized itself to such an extent that it is now attracting sizable attention in financial circles, and it will be but a matter of time until there will be loan agencies set up to make long term loans. I have some idea of my own in this connection which I hope we may be able to put into practice

soon. I am convinced that any agency that does provide such a long term credit, if it be on a sound basis, will reap excellent profits.

Although there is a tremendous need for adequate financing for fishing boat owners, there is almost as great a need for financing seafood packers, dealers, and shippers. In our own area banks are becoming much more liberal toward dealer-shippers, because of a better knowledge of the industry and its needs. Quick freezing and a gradual improvement in packaging and product quality have taken much of the risk out of the dealer-shipper operations; accordingly, bankers are becoming more liberal in their attitude toward this phase of the industry.

In our own case we have found our dealer customers among the most reliable of all business men. We normally lend 80 per cent of the current price of shrimp on cold storage receipts, and we are looking forward to the time when the price structure has been stabilized so that we can raise our lending ratio. I do not know the cause or the cure, but I do know that the price of your product has fluctuated too widely. This lends itself to speculation rather than stabilization, and speculation hurts the whole industry.

We are looking forward to the time when we may be able to convince bigger men of finance, not only of the size and importance of the fishing industry, but also of its stability. Their confidence in the industry should allow any reliable individual who knows his business to obtain any type of financing he needs, so long as his needs conform with sound financing practices.

I recommend to each one of you in the fisheries that you try to be salesmen for your industry — not only in selling your product, but in trying to acquaint your bankers with every detail of what you are doing. I know very well and sometimes you just have to grab them by the ear and make them get out and see what you are doing. All of you can help to acquaint better your bankers and others who could be helpful to you in financing the industry if you will make an effort to do so.

Financing of Fishing Vessels Through the Ship Construction Industry

W. F. ABERLY

Vice President, Gibbs Corporation, Jacksonville, Florida

The commercial fishing industry of the South Atlantic and Gulf areas has, during the past five years, continuously challenged the boat builder and engine dealer, both in design and financial resources, to keep pace with requirements. Of particular importance has been the tremendous growth of the shrimp industry. The comments that follow relate to this segment of the fishing industry, since the activity of Gibbs Corporation in the fisheries during this period of time, has been primarily confined to shrimping.

In 1948, as suppliers of "Packaged Shrimp Trawlers", we were able to meet the demands of industry with vessels 50 feet in length, with 16.5 feet

am, approximately 82 horsepower, 800 gallon fuel capacity and space for approximately 15 tons of ice. In those days, a vessel of this type cost the fishermen approximately \$15,000. In the period when a 50 foot trawler was big enough, electronic equipment was considered excess baggage and the idea of installing freezer equipment in vessels was looked upon as something that was entirely impractical.

Inasmuch as the fishing grounds were only 25 to 50 miles from port, the vessels generally returned to their base at the end of every day, or, at most, the end of every week. If foul weather occurred the vessels remained at the dock, resulting in complete loss of production and giving rise to the usual economic problems of crew welfare, unpaid supply bills and delinquencies in vessel payments.

Now let us examine the present situation. Trawlers have reached a size of 75 feet in length and 20 feet in beam, with horsepower ranging from 120 to 225, with 4,000 to 6,000 gallons fuel capacity (enabling the vessel to operate for at least 40 days continuously) and have ice space of 35 to 50 tons, or refrigeration to accommodate as much as 40,000 pounds of frozen shrimp. These vessels now range in cost from \$40,000 to \$80,000.

Fishing grounds have been extended to cover all of the Gulf of Mexico, requiring a vessel to operate as much as 800 miles from its port. Distances have changed the method of operation, with the result that the vessel usually does not return to port for forty days. Furthermore, the vessel, being more self-sufficient, continues its fishing in good and foul weather alike.

The modern trawler is now outfitted with auxiliary equipment such as depth recorders, radio telephones, radio direction finders, and automatic pilots, all of which have increased the efficiency of the vessel and, at the same time, increased its cost. Refrigeration is being tried at the present time and will, undoubtedly, play an important part in the trawler fleets of tomorrow.

As suppliers of these fishing trawlers, the Gibbs Corporation has been continuously pressed by the industry to meet its various needs, the most important one of which is the initial capital investment for the purchase or replacement of the vessel. The supply of shrimp is good and fishermen are available to man the vessels. The one serious obstacle is the cash required to replace a vessel in operation.

Looking back to 1948, we were able to meet the requirements of the industry by underwriting approximately \$12,000 of mortgage money credit on every vessel sold. Today the requirements extend us to an average of approximately \$25,000 per vessel. In 1948, mortgage credit was extended for twenty four months. Today, we are on a thirty-six to forty-eight months basis, and are studying the possibility of five year mortgage money for the years ahead.

Since 1948 financing institutions have extended mortgage loan credit only against *new vessels* and only if we, as supplier, endorse and guarantee the obligation of the fisherman in every respect. This stringent requirement by the bankers is the result, not of lack of confidence in the shrimp industry, but of a lack of knowledge of the industry, its operations, marketing techniques, and, due in great measure to the reluctance of the industry to bring the bankers into its confidence.

It is a pleasure to report that the shrimp industry has, to date, established

a payment record, with respect to mortgages handled by Gibbs Corporation, which we believe to be the equal of payment records of other acceptable installment loan paper.

The major problem that still confronts us as supplier is one of completely winning the bankers to the point of view of accepting trawler financing in the same light as the financing of capital additions to plants. The trawler is a fine income production unit, covered by insurance for partial or total loss, and warrants the best in credit terms.

It seems to us that it is timely for the industry to invite the appropriate financing institutions to study its operations and not rely solely on the value of the hull or the guarantee of the supplier of the vessel. The character and reputation of the owner, the value of the vessel, the adequacy of insurance, the sources of supply and marketing techniques should be studied by the bankers. If this is done they will learn, as we have, that the present day shrimp boat owner is a man of substantial worth and proven earning ability, who can operate his vessel — which is a production plant — without tremendous overhead in both good and lean earning periods, and produces a product that has rapidly become a standard item of the housewives' food budget, far more in demand than in supply.

Gibbs Corporation, as supplier of trawler vessels and replacement engines, has been confronted by numerous problems in its efforts to give the fisherman the service which it felt was necessary, requiring the management to develop the following policies and procedures:

1. We have made an intensive study of enrollment and documentation requirements, developing forms and procedures enabling us to admeasure and enroll a vessel, as well as record a ship mortgage, all in less than one week. This enables the customer to take immediate delivery with all papers in order. This is of particular value to the bankers, since it enables them to purchase from us fully certified documents.
2. We require continuous observance of U. S. Customs Regulations as they relate to fishing vessels (and more particularly to vessels fishing off foreign coastlines), so that our customers may be informed from time to time of penalties which may be inflicted if regulations are violated, which penalties could place the vessel in jeopardy.
3. We have developed contacts in foreign countries, off whose shores fishing is being conducted, to assist in legal and insurance entanglements should they arise.
4. We supplied the exploratory vessel *Antillas* for one year and we underwrote the expense of its operation to enable scientists of the Fish and Wildlife Service of the United States Department of the Interior to explore possible new grounds and experiment with new fishing gear.

We have undertaken the foregoing in order to gain a full understanding of the problems of the industry so that we could meet its challenge. We now urge the leaders of this fast growing fishery and the bankers to get together. The credit requirements which will arise from the need for larger, more seaworthy and more versatile vessels, will become the responsibility of the bankers and their encouragement and help are necessary.

Financing of Fishing Vessels By Financial Institutions

R. S. MURPHY

Vice President, C.I.T. Corporation, New York, N. Y.

The C.I.T. Corporation has for years financed many kinds of income-producing vessels. These have included fishing vessels and work boats, tug and barges, tankers and lighters. We have also financed the installation of machinery and equipment in vessels — such things as engines, radios, navigational aids and underwater fish-finding instruments. We have enjoyed the opportunity to play a supporting role in the impressive growth of the fishing industry.

The fishing business is constantly changing. Most people are familiar with the advances being made in our knowledge of the sea and its fish; many are equally familiar with the remarkable progress being made in fishing equipment, such as the adaptations of wartime sonar devices to aid in finding fish which support the industry. Many fishermen are working much harder from port than they ever have before and fishing equipment operations are becoming increasingly costly.

In order to meet the climbing costs of boats and equipment the fishing industry often needs outside capital. This is where the industrial financing institution comes into play.

My observations on the financing of vessels and equipment are based on the policies and practices of my own company. Other institutions of a like character have, to a greater or lesser degree, comparable policies and follow similar practices, and I believe that our experiences can be taken as representative of one type of financial agency.

We have two major methods of financing the fishing industry. The first is to work with the engine dealers or yards, the other is to handle the financing directly with the fishermen. The largest volume of our fishing vessel financing is done through dealers or yards. These decide whether the credit of the fisherman is acceptable: they know him personally, they know his skill as a fisherman, the port from which he operates, the grounds he probably works and how he will dispose of his catch. They also decide what the down payment will be and what terms of repayment will be set.

Usually the terms call for a down payment of at least 25 per cent of the purchase price, with the balance to be paid in three years in equal monthly installments. Naturally, this is not an invariable rule, and contracts on some of the larger boats have been written with terms of four and five years.

However, the dealers and yards ordinarily are not so capitalized as to be able to carry large quantities of notes with their own funds, so the industrial financing company discounts the completed transactions for them in order to replenish the dealers' or yards' supply of cash. Thereafter the financing company collects the notes directly from the fisherman. We reserve the right to check the credit of the fisherman and to decide whether the individual risk should be accepted, but we cannot hope to know each fisherman as well as he is known by the engine dealer or yard, and since the transactions are purchased with recourse, we generally rely on the sellers' credit decision and buy the transactions when they are submitted.

It is through this arrangement with sellers that we have handled the financing of a large number of fishing vessels. However, as mentioned earlier we sometimes finance fishing vessels directly for the fisherman. Naturally we cannot handle financing that requires progress payments during construction of a vessel. The industrial finance agency needs a completely documented vessel as security at the time its funds are disbursed. Also, we cannot finance a captain who can supply a down payment but has no other boats or property, no previous history as an owner, and no partners or endorsers. Boat and equipment financing is available, however, to the established captain with a proper financial background. For example, we have handled the financing of complete fishing vessels for owners or captains who already had one or more vessels and were enlarging their fleets. Credit judgment in such cases is based on statements showing a profitable operation of the owners' existing equipment, and an investigation of his character and fishing experience.

We also work with an owner who is buying a vessel jointly with other partners or investors. In this case credit approval follows a satisfactory investigation of the partners' financial statements plus an appraisal of the captain's experience and ability. For instance, we recently financed a trawler for a captain who had two well-known physicians for partners. For the doctors, of course, it was simply an investment with a fisherman whose skill and honesty they respected. It has, incidentally, been a successful partnership.

In some cases we have worked with an owner or captain who has a contract with a processing plant to take his catch. In such instances the processing plant, which has acceptable credit, endorses the notes for the captain.

Terms in these individual cases are fairly flexible and often are tailored to suit special needs. But the general rule, as in our contracts with dealers, is a down payment of at least 25 per cent of the purchase price. The balance is usually paid in not more than thirty-six monthly installments, although some transactions have been written with longer terms.

So far my remarks have been confined largely to transactions for complete boats. However, modernization and replacement of equipment and machinery plays a major part in the fisherman's life. Another form of financing for fishermen is available to meet these problems. Terms are arranged for financing new engines or for replacing or adding the various types of mechanical and electronic gear necessary to modern fishing. Engines and other equipment are frequently financed through the machinery dealer in the fashion previously discussed. The financing can also be arranged directly with the fisherman. This is done by the fisherman giving the financing firm a mortgage on the vessel he owns. Usually the vessel, with the new equipment added, has sufficient value to make a down payment on the equipment unnecessary, although it is preferable to have one. If the value is in doubt the financial institution arranges for an independent appraisal to determine the dollar value of financing suitable for the vessel. These are the financing patterns already set up and tried in practice to cover many financial problems that the fisherman may have.

Now let us come ashore and mention briefly that financing for the fishing industry is not limited to boats and their equipment. Bringing a catch in port is only the first step toward putting fish and fish products in the hands

consumers. Among the things that have enlarged the horizons of the industry and broadened the opportunities for the fishermen are improved methods of handling, processing, preserving, packing and transporting the catch.

All of these operations require machinery and equipment — cooking and freezing equipment, canning and can-closing machinery, refrigeration equipment and many others. Much of this machinery must be financed. Our company alone handles millions of dollars worth of it every year.

Financial institutions recognize that opportunities lie in growing industries. The fishing industry is growing in importance throughout the world and nowhere is its growth more apparent than in the waters of the Caribbean and Gulf — particularly in the shrimping industry. Since we have confidence in the future of the fishing industry, our objective is to aid in its growth through helping to finance the boats and equipment that are needed.

The Financing of the Netherlands Fishing Fleet

PH. VAN GELDEREN

*Assistant to the Agricultural Attache, Netherlands Embassy,
Washington, D. C.*

The financing of the Netherlands fishing fleet has shown some change since the end of the war, to the extent that the investments required to keep the industry going are considerably larger than before the war, and that it is very difficult to obtain long-term capital for this industry.

In the past so-called family partnerships were predominant, mostly in the form of a corporation, sometimes in the form of a limited partnership. It is customary in former years for a shipping mortgage bank or an ordinary bank to provide a family corporation with money in the form of a mortgage, in which case the managing directors of the respective ship-owners' companies were held personally responsible for the fulfillment of the companies' obligations. Thus, the legal form of the corporation was only some sort of protection against the great risks of liability which the dangers of the sea entail.

The Netherlands fishing fleet may be divided into three groups, viz.:

1. The trawlers which are engaged in the so-called "major-fishery" on the North Sea. This group comprises about 45 ships, one third of which are motor vessels and two thirds of which are steam vessels.
2. Motor and steam luggers which are engaged mainly in herring fishery; about 225 ships comprise this fleet.
3. The small inshore fishery, for which motor cutters are used, comprises about 450 ships.

In addition there are a large number of small vessels engaged in oyster, shrimp and mussel fishing on the inland waterways. I shall not go into details about the financing of this group of small vessels.

The ships of the first two groups mentioned are owned by 85 concerns, 95 per cent of which own only one ship. Of the 13 concerns which operate

trawlers, 11 are corporations. Of the trawlers, 60 per cent are from 16 to 40 years old, and replacement of these by new vessels will be necessary in the near future. The cost of replacing a large trawler of about 800 HP is now approximately one million guilders, or \$260,000.

It goes without saying that small family groups cannot raise such large funds, even if part of the money would be furnished by mortgage banks. The same applies to the cost of building new herring luggers of Group 2. A new motor lugger now costs about four hundred thousand guilders, which is equal to \$100,000. Even the smaller inshore vessels mentioned under Group 3 cost approximately two hundred thousand guilders, or \$50,000.

Up to the present time, mortgages have been used in a limited way. Several banks restricted themselves in the granting of mortgages up to a maximum of 50 per cent of the value estimated by their appraisers. The terms are usually 5 to 10 years, depending on the condition of the collateral.

If it proves impossible to obtain a mortgage from a bank an appeal can be made to the "Recovery Bank", founded after the war, which bases its credit grants more on the operating results than on the value of the collateral.

Up until now it has been the customary procedure, at least in many cases when a fishing vessel was bought by one person or concern, that certain trades people, mainly the suppliers of the oil or the coal, participated in the furnishing of the necessary funds for the purchase of the ship.

Whether the payments on these credits could be made usually depended on the operating results. It has happened that the tradesman who granted such a credit ultimately suffered a loss on his investment, but such losses were as a rule wholly or partly compensated by the profits made on the sales of fuel and supplies over a large number of years.

Inasmuch as the owners of fishing vessels in the years immediately preceding the last war were dependent on Government support in some form (although it cannot be said that there was actually a depression) it is understandable that neutral investors were not exactly keen on investing their money in this industry.

As a result there are very few shipowning concerns whose shares are in the hands of outsiders; these shares are not quoted in the official Stock Exchange listings, but they do appear in the separate listings of securities which are called "non-marketable shares".

The Government is aware of the difficulties involved in the building and financing of new ships, and recently instructed a "Committee for the Reorganization of the Sea Fishing Industry" to report on this problem. Briefly summarized, the report of this Committee states that there is little need for short-term capital or short-term credit. In view of the fact that the proceeds of the catches are immediately made available to the shipowners' companies to pay their operating costs, in most cases only long-term capital is needed for the purpose of financing the purchase of a new ship.

Among other things the Committee has proposed the founding of a Fisheries Bank, which supposedly would grant a credit of 50 per cent on the building expenses of a new ship. The Committee has further reasoned that 25 per cent of the building expenses should be met by the shipowners themselves, and 25 per cent in the form of a first mortgage. If a fishery

nk should actually be formed these percentages might be changed. It is
ar that the existing shipowners' companies can hardly finance the building
new ships, whereas it cannot be expected that private investors outside
e industry will make any considerable investments in this field.

It is not the intention here to present a gloomy picture of the condition
the fishing fleet in the Netherlands. It should be remembered that war
d occupation wrought destruction among the Dutch fishing fleets, from
which the industry has now largely recovered through the efforts of the
etherlands people.

In the face of the present problems we in the Netherlands will not fail
reorganize our fishing fleets in time, and thus see to it that the fishing
dustry will remain to be one of the most flourishing in our country. The
overnment and private enterprise will no doubt work together to achieve
e replacing of part of the fleet by new ships. Government's assistance, if
ecessary, will be a temporary one, until the fishing industry will be able to
te that it has fully overcome the effects of the war, and, as in former years,
ill have a fleet worthy of the position which the Netherlands as a fishing
tion has occupied through the ages.

Financing of Fishing Vessels In Denmark

ERIK JACOBSEN

Fisheries Attache, Danish Consulate General, New York, N. Y.

Before approaching the subject of the financing of fishing vessels, it would
e useful to give a brief description of how the Danish fishing fleet is built
and how a fishing vessel may serve as security for a loan in Denmark.

In 1952 there were 2878 fishing vessels in Denmark ranging from five to
9 gross tons and 758 fishing vessels of 20 gross tons or more. The present
endency is towards building strong and seaworthy wooden vessels of 30 to
gross tons, with diesel engines of about 100 HP, whose purchase value
y be estimated at approximately \$20,000. Just as in the Danish farming,
ing in Denmark is also accomplished in small units. As a rule, the
pper entirely or partly owns his ship. There are only a few fishing
panies that own more than one or two fishing vessels, and these fishing
panies should not be considered as characteristic.

In some cases the skipper's father or his brother is a partner of the ship.
The vessel is built and equipped in such a way that it may be used for the
ing of several different species. Fishing vessels especially built for tuna
ing or shrimp fishing alone, do not exist in Denmark.

Every fishing vessel is, of course, registered in a port. Furthermore, all
ing vessels of 20 gross tons or more are listed in a Ship Register. To
strate the importance of this Ship Register, the writer wants to point out
ht all land in Denmark is listed in a special Land Register with drawings
r measurements of the land concerned. Through this system it is possible
etermine who has owned the land concerned for several hundred years,
r which buildings have been erected on it. The Land Register also states
ether or not an area has served as security for any commitments and to

whose benefit the security has been given; in this way a landowner cannot possibly avoid his financial commitments. The Ship Register works in the same manner as the Land Register, and therefore vessels of 20 gross tons or more are excellent securities for loans. Fishing vessels registered in the Ship Register are subject to laws which are identical with the International Maritime Laws in regard to mortgage-security and commitments made during fishing trips or during the stay in port. However, all vessels of less than 20 gross tons are considered as movables as far as mortgage-security goes. Therefore, if a fisherman raises a loan and a vessel of less than 20 gross tons serves as security, the pledge is registered in the district court where he resides but it is not entered in the Ship Register. As long as the skipper does not move, the boat will be sufficient security for the lender, but if the skipper moves to another district and the lender does not see to it that his pledge is legally notified there, the lender will lose his mortgage-security in case the skipper sells the fishing vessel to a person acting in good faith. An alteration of the law on registration of vessels may change this situation so that vessels ranging from 5 to 19.9 gross tons will also be listed in the Ship Register within a couple of years.

The financing of the Danish fishing fleet is characterized by the fact that the fishing industry is less important than the country's other industries, and therefore there are no loan agencies to meet the special needs of the fishing fleet for capital.

Loans for purchase of new or second-hand fishing vessels were previously given exclusively by commercial banks who knew the local fishermen personally, but as the fishing in Denmark is not concentrated on a limited number of large fishing ports where the commercial banks could acquire a thorough knowledge of the profitableness of the fishing, there is a tendency that loans given through commercial banks are relatively small compared with the purchase value of the fishing vessels. As deposits in the commercial banks may in general be withdrawn on request, the banks are not in a position to give long term credits; therefore it is rather common that the loans must be repaid in the course of 5 to 8 years. Furthermore, the commercial banks must take into consideration that in acute situations they may be forced to supplement their cash balances by securing short term loans in the free money market, and thus their interest rates are in general higher than the interest rates paid on long term loans with security on real estate. However, it should be mentioned that in one particular fishing port it is rather common for fishermen to secure loans for the purchase of fishing vessels in the form of a cash-credit to be repaid over a period of 5 to 10 years. The interest on a cash-credit can be burdensome to a fisherman, but if in periods of good catches he has some spare money, he may pay off his cash-credit loans and then later on withdraw it, in case he needs the money in periods of bad fishing. In this way he has the possibility of reducing his average yearly interest. One commercial bank in Denmark can issue long term bonds for sale on the free money market, but it is not known whether this money has been used for the financing of fishing vessels. What has been mentioned above regarding bank loans for purchase of fishing vessels also goes for purchases of new diesel engines or for example echo sounders; usually, however, the bank loan must, in such cases, be repaid within five years.

Besides the commercial banks Denmark has a rather large number of well added savings companies which, to a certain extent, are organized as non-profit organizations. Their activities are limited to the amounts that private persons deposit in savings accounts. The deposits may be withdrawn on request or in three or six months terms, but these savings companies permanently dispose of such large sums that they can give credits for fairly long terms. The savings companies give loans to the local population against mortgage-security and guarantee, and their means have been employed on a limited scale for the financing of purchases of fishing vessels. The rate of interest of the savings companies is often a little lower than that of the commercial banks. Whether the fisherman secures a loan in a commercial bank or in a savings company, the loan generally is not given for more than approximately half of the value of the fishing vessel. If the fisherman can furnish further security in the form of real estate or guarantors, the loan usually may be somewhat increased, but no fixed lines can be given in all cases.

However, to a fisherman loans raised in a bank or in a savings company can be burdensome, because the rate of interest is nearly always higher and the term of the credit shorter than in the case of loans given against security in land, buildings or factories. To meet the fishing industry's needs for credits, a bill was passed in 1932 under which a Bank for Fisheries was established for the financing of purchases of fishing vessels and, on a limited scale, for the building of industrial plants within the fishing industry. The working capital of the Bank for Fisheries was granted by the Government and consisted of funds from a pool created during World War I. This working capital amounted to D. Cr. 5,000,000, or a little over \$700,000 at the present rate of exchange. Furthermore, the Bank for Fisheries was authorized to issue governmentally guaranteed bonds so that the total working capital of the Bank for Fisheries amounts to about D. Cr. 15,000,000, or about \$2,200,000.

As the bonds of the Bank for Fisheries are governmentally guaranteed, they can be sold on the money market at a very favorable rate of exchange, and therefore the interest on loans given by the Bank for Fisheries is, as a rule, only as low as credits made against security in real estate. The administrative expenses of the Bank for Fisheries, which at the moment amount to about 100,000 yearly, are covered by the Government. Nevertheless, on all the credits of the Bank for Fisheries one must, in addition to the interest, pay an amount of one quarter per cent every six months of the debt for the reserve fund, but this amount is added to the working capital of the Bank for Fisheries and is thus the basis for increased credits.

Loans in the Bank for Fisheries are the cheapest form of financing within the fishing industry and it is therefore a matter of course that most fishermen naturally try to secure a loan in the Bank for Fisheries. The rate of interest in the Bank for Fisheries is for the time being five per cent, as compared with four and a half per cent on an ordinary loan against first mortgage security in real estate.

In the year of 1952 the Bank for Fisheries filed 181 applications for loans. In the same year the Bank for Fisheries made 48 loans at a total amount of approximately D. Cr. 1,460,000, or a little over \$200,000, for purchases of fishing vessels, and 68 loans at a total amount of D. Cr. 500,000, or a little

over \$70,000, for purchases of new diesel engines or echo sounders for fishing vessels. In 1952 the Bank for Fisheries furthermore issued eight loans at a total of D. Cr. 547,600, or about \$80,000, for canneries, processors, etc.

The total credits of the Bank for Fisheries amounted to D. Cr. 12,944,000, or about \$1,875,000, on January 1, 1953. The Board of Directors of the Bank for Fisheries consists of a representative of the Ministry for Fisheries, a representative of the fishing industry and a representative of the Ministry of Finance. According to the statutes of the Bank for Fisheries, loans are issued exclusively on a purely objective basis, and where the security given may be considered safe from a banker's point of view. Administrative considerations as to whether a loan for one purpose or another would be most appropriate, never occur. It must be added that the Bank for Fisheries has in certain periods been unable to meet the requirements of credits.

As a rule, the Bank for Fisheries gives loans against a first mortgage security on fishing vessels, and generally these loans are given for approximately half of the value of the fishing vessel; as a rule, the term of repayment is 10 years for purchases of fishing vessels and about five years for purchases of new diesel engines and echo sounders.

However advantageous a loan in the Bank for Fisheries may be to a fisherman, it must be admitted that there are few fishermen who are in a position to finance the second half of the purchase value of the vessel themselves. A fisherman may be able to secure a private bank loan insofar as he can give security in the form of real estate, or if he can provide guarantors, but generally such credits will be very expensive. Therefore various laws were passed securing additional means of credits for active fishermen for the purchase of new fishing vessels. These loans were made for approximately 20 per cent of the purchase value of the fishing vessel, so that the total credit amounted to approximately 70 per cent of the purchase value of the fishing vessel. The loans were issued against second mortgage security on the vessel and usually had to be repaid within 10 years. The rate of interest has varied according to the conditions on the money market at the time when the loan was raised. None of these laws is in force any more.

At the beginning of World War II a form of loans was adopted for purchases of fishing vessels, which should be mentioned. At that time food was scarce, and in order to increase fishing for fish for human consumption a bill was passed providing means for active fishermen, who could show personal savings out of their income from fishing, to purchase new fishing vessels. The loans were to be repaid over a period of 10 years, and the rate of interest was rather low. The loans were made for approximately 10 per cent of the purchase value of the vessel, and in connection with credits from the Bank for Fisheries or a commercial bank and the aforementioned government credits the fisherman could thus secure a loan covering 80 per cent of the purchase value of the fishing vessel. This 10 per cent law has also expired and the last loans will be repaid in about one year from now. The interesting point about this 10 per cent law, however, was that at that time everybody believed that the price level was going to be lowered after the end of the war and in order to increase the fishermen's interest in this

d of loan it was decided that one per cent of the loan was to be regarded each year, so that totally 10 per cent of the loan given according this law, equal to one per cent of the purchase value of the vessel, should be repaid if the fisherman would strictly observe the conditions of payment and keep his vessel in good repair.

Financing Fishing Vessels In Sweden

JAN-OLOF TRAUNG

Naval Architect, FAO, Rome, Italy

In Sweden sea-going wooden fishing boats 70 to 80 feet long cost about \$10,000 to \$50,000. A Government loan-fund was established in 1932 to provide loans for the procurement of boats, engines or other mechanical equipment, gear, fish-transport vehicles, small boats and other transport facilities, small fish plants and for fish farming. Each year a sum of \$2,000,000 (\$400,000) is being loaned. The maximum value for each loan was increased in 1943 to \$24,000. Unfortunately, the number of applications is so large that the available amount is usually insufficient. It frequently happens, therefore, that the amount requested has to be reduced. The government requires the first mortgage on the vessel, and for some responsible person to stand security. For the first two years no payments of principal or interest are required. Thereafter principal and interest have to be paid by equal instalments over a period of a maximum of 10 years. The interest is 3.6 per cent and the penalty interest six per cent.

For 1954 the Government estimates that they will receive from fishermen \$1,300,000 (\$260,000) in repayments on old loans. Accordingly the Government is going to increase the loan fund by Kr. 700,000 (\$140,000) to make loans possible up to a total value of \$400,000 in 1954.

In order to obtain a loan, the fisherman sends an application to the Agricultural Society in his part of Sweden or, if he is living in West Sweden, to the County Council. This body scrutinizes the application and, in the case of an Agricultural Society, it has to make an additional endorsement. The loan application is then sent to the Board of Fisheries for approval or possible adjustment of the sum. If approved, the Board informs the Treasury which then pays the loan sum by cheque to the Agricultural Society or the County Council for payment to the fisherman, once he has produced the necessary guarantees.

In addition to the Government loans, the fishermen frequently use the credit facilities provided by the Provincial Savings Banks or Commercial Banks, and usually a fisherman can buy a new boat without contributing more than 20-25 per cent of the cost himself. The savings banks charge an interest of about four per cent and require that the loan be paid back in 10 years. They demand security over and above the mortgage. Some Commercial banks also provide similar loans and presently charge four and a half per cent interest for loans shorter than three months and five per cent for loans longer than this period.

The experience in Sweden is that fishermen are good borrowers and the losses are insignificant.

DISCUSSION

Economic Session

Discussion Leader: RICHARD A. KAHN

Discussion Panel: PHILIP VAN GELDERON, ERIK JACOBSEN, PETER BOE,
CHARLES B. BOWLING, JAN-OLAF TRAUNG

- Q. Wegmann: Mr. Faubion, would you elaborate on the extensions of loans to the small fisherman and the financing of small used fishing vessels.
- A. Faubion: Our bank has set a limit of about 50 feet on fishing vessels that we finance. This limit has been set primarily because the demand in Texas is for boats of 50 feet or more. We do, however, help fishermen having smaller boats, say of 30-40 feet, but this financing is more on a personal basis rather than a collateral one.
- Q. Woodward: Mr. Faubion, would you elaborate on controllership frequency after these loans are made. What about the determination of cost?
- A. Faubion: We require every man who has a sizeable loan from our bank to submit to us a quarterly operation statement. We also require that we have his bank account at our bank.
- Q. Williams: Would your bank consider a down payment of 20 percent if it were endorsed by a shipyard, etc.?
- A. Faubion: Yes, we would accept a down payment of 25 percent if properly endorsed; however, we try not to exceed two-thirds of the value.
- Q. White-Spunner: Mr. Faubion, what assurance do you have that the insurer will stay on the risk during the life of the loan? I have had the insurer get off because of the risk involved. What assurance do you have that this won't happen?
- A. Faubion: We have no assurance that he won't. I honestly don't know the answer. We try to be practical about who insures boats.
- Q. White-Spunner: You said that your bank financed up to 80 percent of the value of the vessel. Is this figure based on the market value or the intrinsic value?
- A. Faubion: It is figured after it has been marketed and the value frozen.
- A. Jacobsen: Regarding insurance, fishing vessels in Denmark are registered in shipping (fishery) regulations when exceeding 20 gross tons. In case the owner doesn't pay the premium, it goes as an A1 security ahead of mortgage commitment.
- Q. Wegmann: Will Mr. Murphy elaborate on small vessel finance?
- A. Murphy: I can't add to Mr. Faubion's remarks, we also tend to finance the larger vessels.
- Q. Would you consider a small fishing vessel loan if a

- aspects were taken to be a good risk? We have small boat operators who need financial help to become bigger.
- Murphy: It is purely a question of credit. Small operators are usually men of small means. Frankly I doubt if the smaller fisherman could get papers showing the proper security, for example, statements of profit and loss, income, etc., and of course we'd like to have accurate figures on his actual worth.
- Woodward: Mr. Murphy, isn't it true that since smaller operators cannot operate economically they are less good risks?
- Murphy: Yes, I think that is right.
- Wegmann: I would like to recount a couple of experiences concerning the ability of the small boat operator. On two occasions I have sold company boats to the men who had worked for me for two to five years. I knew their reputation and had great faith in them. I required no down payments and gave them 50 months to pay at five percent interest. This gave them the opportunity to get started in their own business which would have been impossible if a down payment had been required. One captain paid for the boat in much less than the allotted time—23 months—and now owns his home and car. The other man is still paying for his boat, but I've been gratified, since he's brought in more shrimp and the boat is kept in better condition than when I owned it. Would you do this, Mr. Murphy?
- Murphy: We'd ask for your endorsement.
- White-Spunner: Mr. Faubion, when you said that it would take longer to pay off a \$100,000 loan when boats get larger than the present-day \$50,000 shrimp boat, you were referring to the problem of increased income and increased taxes?
- Faubion: That's my only point.
- Taylor: Mr. Faubion, how many of the vessels financed by your bank were paid off by insurance companies?
- Faubion: We haven't lost one vessel. A few were detained in Mexico but they always got back.
- Kahn: If a vessel that is being financed is seized, say by Mexico, who pays for the vessel?
- Murphy: Seizure is not paid by insurance companies. Most insurance policies do not cover the vessel during time of war. However, for \$140 per man per year, which equals a \$50,000 fishing vessel, some insurance companies will insure a boat against seizure.
- Taylor: Bankers have taken a liberal attitude toward shrimpers because they pay off their debts. I have problems with the hook and line fisherman. Could the present type of fishing vessel be replaced by a more efficient one, that is one that could be adopted for various phases of fishing, and if it could be, could it be financed?
- Faubion: Lately it has been seen that specialization of fishing

vessels is the keynote, from this I'd say that it wouldn't be likely.

Q.

A question for Mr. Murphy involving technique of handling papers on improvement of vessels. For example, an owner of a 75 foot vessel worth \$60,000 wants to install refrigeration equipment thereby spending \$12,000 to \$14,000. Would Mr. Murphy finance this? If so, how would you finance this?

A. Murphy:

We finance the seller and the dealer, but with recovery on the seller. If financing is direct, then we would want a mortgage on the vessel.

Q.

What if there were a chattel mortgage on the equipment? Would you clarify this?

A. Murphy:

I can't clarify it, but my opinion is that there would be some difficulty. We would not go in if the vessel is under liable.

Q. Kahn:

A firm in Boston asked for \$2,000,000 for expanding; this was not for improvements. Can anybody get a loan for the purpose of business expansion?

A. Faubion:

That would, of course, depend upon the particular situation and the man or firm as the case might be.

A. Aberly:

Engine dealers have asked for financing to re-power engines and rigging. The difficulty in getting money is determining if any liens exist on that vessel. Some marine liens can exist for three years and never be recorded. If we finance a vessel to be re-powered, an already, but unknown, existing lien may be served against the vessel which would receive action before ours.

THURSDAY—NOVEMBER 19

Chairman—F. G. WALTON SMITH, Director Marine Laboratory,
University of Miami

Fisheries Dynamics and the Concept of Maximum Equilibrium Catch

MILNER B. SCHAEFER

Inter-American Tropical Tuna Commission, La Jolla, California

Development of the concept of maximum equilibrium catch

Although fishing is one of man's oldest occupations, and many of the sea fisheries are very ancient, they were generally, until modern times, of rather low intensity. Consequently the "overfishing" problem did not arise. With the application of power to fishing vessels (first steam and later internal combustion engines) beginning in the latter part of the last century, the output of fishing and the total catch from the sea fisheries rapidly increased. The catch did not generally increase as rapidly as the fishing effort, however, and in such heavily fished areas as the North Sea questions soon became acute as to the effects of heavy fishing on the fish stocks and as to possible damage to future harvests of too intensive a fishery. Obtaining quantitative answers to such questions became the business of a large number of researchers. And many of us are so engaged at the present time.

The first question, of course, is whether the amount of a given kind of fish which man is able to take from the sea is sufficient to have any noticeable effect at all on the supply. This matter was discussed very early by McIntosh (1889), Garstang (1900), and others. It was a controversial matter then, and continued so for some years. The subsequent history of the fisheries for the North Sea demersal species, the Pacific halibut, the haddock of Iceland and the Northwest Atlantic, and of numerous other fisheries, leaves little doubt as to this score. There is yet a good deal of controversy among students of these matters as to the relative importance of fishing, as opposed to other causes of changes of population abundance and catch, on particular fish stocks. However, nearly all researchers are convinced that a modern commercial fishery can, and sometimes does, have a pronounced effect on the fish population being exploited, and that it can become so intense as to reduce the population to a degree that the harvest may also be diminished. There are, of course, those, however, who will not agree to the latter point. Huntsman (1953), for example, states that "The high reproductive rate that obtains in most fishes . . . permits man to remove very large proportions of populations of fish in suitable environments without affecting future generations of the fish. It gives also the likelihood that fishing will never be so intense as to decrease the take of fish in the long run, except where practically the whole stock can be removed." And again, "There seems to be no good basis for restricting fishing in order to increase the long term yield." Dr. Huntsman appears to believe that the very obvious changes which have taken place in the yields of a number of our great fisheries, and which are well documented by sound statistical data over many years, are merely results of natural fluctua-

tions in population numbers, and that the very clear relationship of these changes to changes in the intensity of fishing is purely coincidental. Since the same pattern of changes in catch and in catch per unit of fishing effort has been observed to follow increased intensity of fishing in a good many fisheries, as shown for example by Russell (1939, 1942), this would seem to beg too much of coincidence. Most convincing of all, perhaps, is the very notable effects on some North Sea and Atlantic fish stocks of the respites from fishing which occurred during the two world wars, and which have been discussed in scientific symposia under the auspices of the International Council for the Exploration of the Sea, the last having been held in 1947.

The sequence of events when a stock of fish is subjected to a fishery of increasing intensity is well known. In the early period of the fishery, when the annual catch is small, the average catch per unit of effort is high, corresponding to a high abundance of the fish population. With increasing intensity the annual catch increases, though not in proportion to the increased intensity of fishing; meanwhile the abundance decreases. Eventually, if the fish are sufficiently valuable to make fishing economically possible at quite low population levels, as the intensity is still further increased, the total catch falls off as well. Finally, when the abundance has fallen to a point where the fishery is not attractive to more fishermen, the intensity ceases to increase, and may even decrease, so that the amount of fishing and the catch tend to remain at a more or less constant level. This level is determined, of course, not by the total catch but by the catch per unit of effort and the value of a unit of catch.

This sequence of events seems capable of a rather simple interpretation in terms of the dynamics of the fish stock. Initially, when there is no fishing, the natural losses from the stock are, on the average, just equal to the increments to the stock due to reproduction and growth. With the removal of a part of the stock by fishing, it is reduced to a lower abundance, but at this lower abundance its rate of replacement is larger, so that the removals from fishing are at least partially offset by the ability of the fish at lower population levels to reproduce, survive and grow better. The amount which the population can produce by the annual excess growth and reproduction over losses due to natural causes we may term the natural rate of increase for the given level of population. If, at any level of population, only that amount is caught each year which is capable of being produced each year by this natural rate of increase, the population, and the catch, would remain stabilized on the average. The catch which can, on the average, be obtained at a given level of population, without resulting in any net change in the size of the population, may be termed the equilibrium catch, because it is the catch which is in equilibrium with the productivity of the population at the given level.

Now, as the fishery becomes increasingly intense and continues to remove each year a catch in excess of the equilibrium catch, the population falls continuously. The natural rate of increase and the corresponding equilibrium catch, however, rise for a time as the population falls. There is eventually reached a population level at which the equilibrium catch is maximal. Further increase in fishing intensity drives the population down to levels where the natural rate of increase, and the corresponding equilibrium catch, is less than the maximum. This is the writer's concept of what is meant by "overfishing."

It should be pointed out, as has been indicated by Thompson (1952),

the intensity of fishing which will be applied, not only to the population as a whole, but to each separate component, depends on the density of the stock, which is detected by the fishermen as the catch per unit of effort expended. In attempting to maximize their profits fishermen will constantly attempt to fish the greatest concentrations of fish, so that the stock and each of its components in an unregulated fishery is reduced to that level at which further increase in effort proves to be no longer profitable. Thus, the population level at which the fishery will tend to stabilize itself bears no necessary relation to the level of maximum equilibrium catch, but may be above or below it, depending on the unit value of the catch. If the unit value of the catch is sufficiently low, the fishery will cease to increase in intensity before the level of maximum equilibrium catch is obtained, and overfishing is, in this case, not economically possible. For a good many of the sea fisheries, however, it has been shown by experience that the unit value of the catch is high enough so that the intensity can and does increase to a degree that reduces the equilibrium catch below the maximum.

Objectives of research on fisheries dynamics

It is conceived here that among the primary practical objectives of research on the dynamics of commercial fish populations and the fisheries on them

- 1) To determine for a commercial fish stock whether the existing population level is above or below that corresponding to the maximum equilibrium catch.
- 2) To provide estimates of the population level, and corresponding fishing intensity, which will provide the maximum equilibrium catch.

In attaining these objectives, fisheries researchers are, of course, faced with a number of difficulties arising from the complexities of the biology and ecology of fish populations. Most outstanding, perhaps, is that the concepts of the population-dependent natural rate of increase and the corresponding equilibrium catch can be applied only to average values of a number of years, since, due to the great variability of environmental and biological factors affecting recruitment, growth, and mortality, the actual increments to the population vary a good deal from year to year. In application, this variation from the mean values must be discounted. In a good many fisheries, particularly those using trawls or gill nets, the gear is selective by size of fish, so that not only the magnitude of the stock but its size composition is to be considered, since, by regulation of mesh sizes, the intensity of fishing on different sizes of fish may be controlled. Again, as has been pointed out by Huxford and Bell (1952), a stock of sea fish may consist of a number of components, semi-discrete in their seasonal behavior patterns, upon which the intensity of fishing may bear unevenly. Although these and other problems make difficult the most refined estimates, the application of some rather simple theory, developed during the last few decades, has made possible considerable progress toward the objectives stated above. It is, at least, possible to calculate sufficiently good approximations for the improvement of the catch of many sea fisheries by control of fishing effort or catch.

General formulation of the problem of estimating equilibrium catch

In order to treat quantitatively the problem of estimating equilibrium catch and maximum equilibrium catch, it is necessary to erect some mathe-

instantaneous rate of fishing mortality is proportional to the fishing intensity (number of units of fishing effort). Under these assumptions he computed the equilibrium catch for a population of fish, having a specified rate of increase of length with time, for various values of natural mortality rate and fishing intensity.

Thompson and Bell (1934) computed the equilibrium catch for various rates of fishing mortality, under the assumptions that recruitment is constant, percentage rate of growth is constant, and percentage rate of natural mortality is constant. They also computed changes in population and yield which would be expected in the halibut fishery, assuming recruitment constant, percentage rate of natural mortality constant, growth to be age-specific (following average age-weight data from samples of the stock), but constant at each age for all sizes of population, and instantaneous fishing mortality rate to be proportional to number of units of gear fished. With these simplified assumptions they found the calculated changes in abundance and catch responded rather well with the actual changes over the period of years examined.

Kicker (1944), in reviewing this type of calculation, points out that the assumptions that certain of the rates involved remain constant when the fishing effort — and consequently the size of the population — changes do not correspond to reality, so that such calculations cannot be valid over a very large range of population sizes. In point of fact the rates of recruitment, growth, and natural mortality may all be expected to be dependent on population density.

Parrish and Jones (1953) have computed the equilibrium catch assuming recruitment constant, percentage rate of natural mortality constant, and growth rate to be age-specific, following a particular mathematical form due to Bertalanffy, but constant at each age for different population densities, and the instantaneous fishing mortality rate to be proportional to the amount of gear fished. They have computed curves of equilibrium catch versus rate of fishing for two different values of natural mortality rate. They state, however, "Of course, these curves are not valid over their whole range, since with decrease in stock density, there will possibly be some decrease in growth rate and increase in natural mortality rate, so that the ordinates to the left of the curve (lower fishing intensity) are probably over-estimates." Since recruitment must fall off, also, at very low levels of population, the values computed for very high fishing rates are doubtless also over-estimates.

Everton (1953) has made similar calculations, based on the same assumptions and similar methodology, to those of Parrish and Jones. He has also made calculations of the variations in equilibrium yield for a trawl fishery, where the effect of variation in age at recruitment, due to regulation of size of mesh of net, is taken into account.

This type of approach seems adequate to indicate when a fishery has been overfished, and to indicate the direction regulations need to take. Quoting Everton (1953) "... the model can establish the main dynamic properties of a fishery and can indicate the first steps which are required to regulate it. But for making accurate predictions of the regulation required and of its probable effects it is necessary to take other factors into account. Of particular importance here is the variations of the parameters of population density. Introducing phenomena of this kind makes the model more realistic

Returning to equation (3) and writing ΔP for the change in population during the year, we have

$$\Delta P = \bar{f}(\bar{P}) - C \quad (4)$$

we may assume, as is usually done in fisheries dynamics, that the catch per unit of fishing effort is proportional to the mean population encountered by the fishery during the year, and that the instantaneous rate of fishing mortality is proportional to the intensity of fishing (number of units of fishing effort), we obtain

$$\Delta P = \bar{f}(\bar{P}) - K_2 F_t \bar{P} \quad (5)$$

where F_t is the total number of units of effort during the year, $\bar{P}$ is the mean population, and K_2 is a constant.

$K_2 F_t$ is, of course, the instantaneous fishing mortality rate, so that K_2 may be evaluated from data of marking experiments, or by other means.*

Since $K_2 \bar{P} = U$, where U is the catch per unit of effort, which is available from the usual catch statistical data, we can, knowing K_2 , estimate $\bar{P}$ each year of a series for which suitable catch statistics are available. From a series of values of $\bar{P}$ we can estimate the population at the beginning and end of each year, approximately, by interpolation, and thus estimate ΔP . From estimates of ΔP and the catch, we can estimate $\bar{f}(\bar{P})$ for each year of the series.

When we plot the estimates of $\bar{f}(\bar{P})$ against $\bar{P}$, the points would fall on a straight line if there were no other influences than the population growth law relating these two variables. Actually, due to effects of variable environmental factors, measurement errors, and other unaccounted-for sources of variation, the points will scatter about an average curve. By observing the trend of the points against $\bar{P}$, however, we may ascertain how the equilibrium catch varies, on the average, with population size.

This may be illustrated by the data of the Pacific sardine fishery. The constant K_2 was evaluated from data of tagging experiments. In Figure 1 is shown the values of $\bar{f}(\bar{P})$ estimated for the years 1933 through 1950, plotted against U (which is proportional to $\bar{P}$). It may be seen that although there is a good deal of scatter, the trend of the relationship is clearly evident.

Similarly, for Pacific halibut of the southern grounds (Area 2), we have estimated the constant K_2 from tagging data. Using this and the record of effort and catch per unit of effort, we have made estimates of equilibrium catch for each year from 1916 through 1946. In Figure 2 are plotted these estimates of estimated annual equilibrium catch, $\bar{f}(\bar{P})$, against the corresponding values of $\bar{P}$ (and U). The means of these values of $\bar{f}(\bar{P})$ for each ten units of $\bar{P}$ have also been plotted (the centers of the crosses). It may be seen that $\bar{f}(\bar{P})$ increases with stock size up to a catch per unit of about 80 pounds per

Tompson (1950) has estimated this constant for the Pacific halibut by considering the changes in catch and stock over a period of years when the stock declined and then returned toward its original condition. His method of calculation involves, however, the assumption that $\bar{f}(\bar{P})$ is constant over the period. This assumption obviously is not acceptable over more than a very small range of stock sizes.

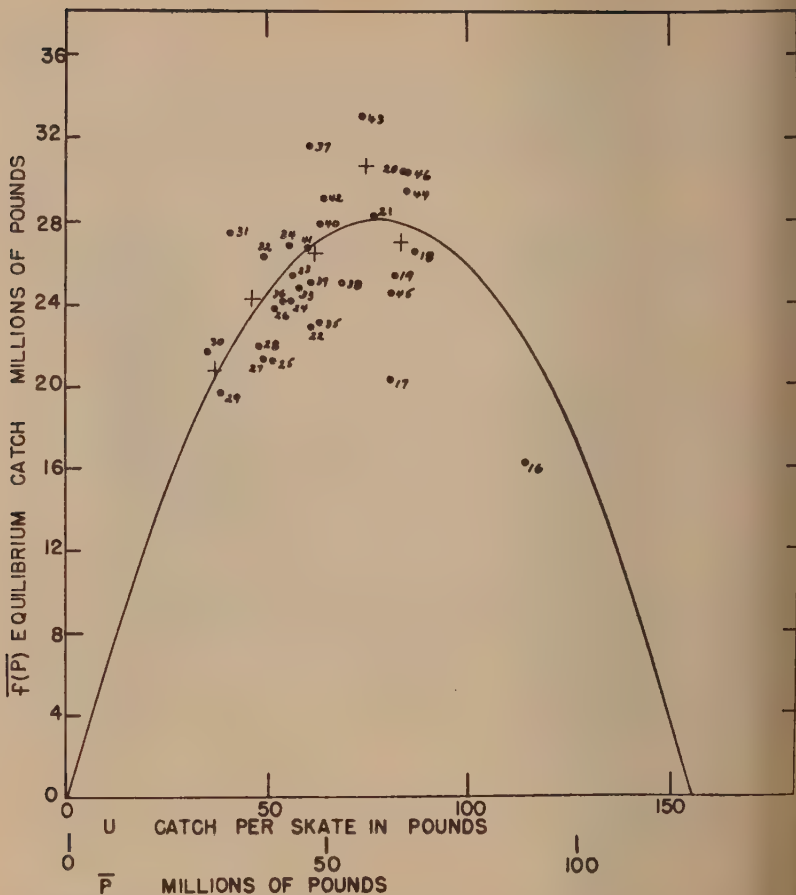


FIGURE 1 Relationship between population and estimated equilibrium catch, Pacific sardine. (Numbers indicate calendar years to which points correspond.)

skate, at least, corresponding to a mean population of some 62,000,000 pounds.

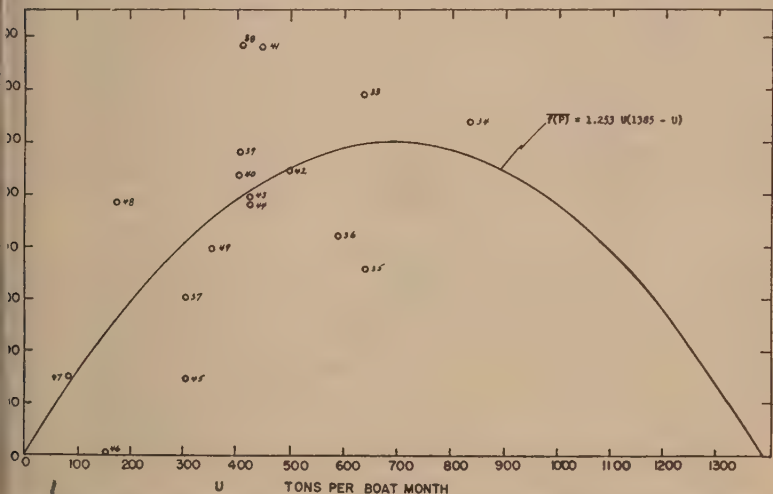
If we further specify the form of the relationship between $\bar{f}(\bar{P})$ and $\bar{P}$, or U , which is the same thing, we may fit a curve of the specified form to the points on these graphs. There seems to be reason to believe that the Verhulst-Pearl logistic adequately describes the growth of marine fish populations. This law

$$\bar{f}(\bar{P}) = K_1 \bar{P} (L - \bar{P}) \quad (6)$$

is the same employed by Graham (1935) as a basis for his analysis of the North Sea demersal fish stocks.

Specifying a curve of this form, we have fitted a curve to the sardine data,

Under a criterion of least squares, as illustrated in Figure 1. From this curve we would estimate that the maximum equilibrium catch is about 600,000 tons per year at a mean population level corresponding to a catch per unit effort of 692 tons per boat month.



we have a graphic illustration of the effect of fishing on the stock, and the historical course of changes in fishing intensity, stock, and catch, in relation to the equilibrium catch. Such a diagram is shown in Figure 3 for the Pacific halibut of the southern grounds, the constants for the line of equilibrium conditions having been estimated as described above.

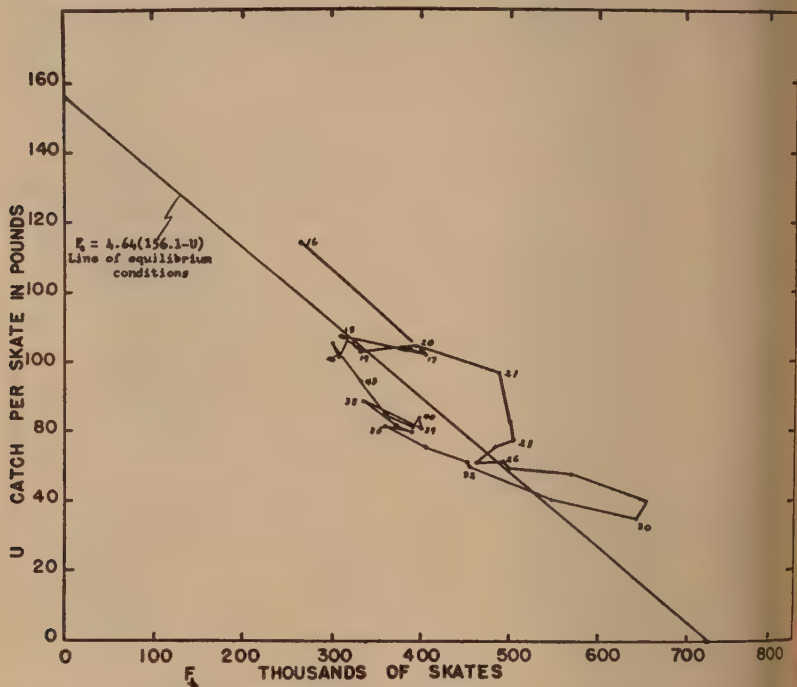


FIGURE 3—Relationship between intensity of fishing and mean population, Pacific halibut south of Cape Spencer (Area 2), 1916 to 1947.

In such a diagram as this, if (7) adequately describes the effect of stock size on natural rate of increase, and effect of fishing on the stock, we will expect that when (F_t, U) falls above the line of equilibrium conditions (the catch being greater than the equilibrium catch for the given size of stock) the population and the catch per unit of effort will decrease. Conversely, when (F_t, U) falls below the line of equilibrium conditions, the stock and catch per unit effort will increase.

We may see that the course of events in the halibut fishery was just what would be expected from the theory. From 1916 until 1930, the points fall generally above the line of equilibrium conditions, and the stock is rather steadily decreasing. Regulation of the fishery — which curtailed the fishing intensity — commenced in 1931. From 1932 to 1947, during which the stock was being built up, the values of (F_t, U) fall below the line of equilibrium conditions, approaching it closely in the latter years when the fishery was becoming stabilized under regulation.

This approach — from the laws of population growth—to the estimation

equilibrium catch at different stock sizes, and of the maximum equilibrium catch, seems to be one of the more promising recent developments in the field of fishery dynamics. It offers a means of estimating the status of a fishery, and indicating the direction, if any, which management needs to take to improve the sustainable catch. It makes possible such estimates without information on age composition, rates of growth, and rates of natural mortality, which are difficult to obtain in sufficient detail for many fisheries. As applied in the foregoing examples, this approach requires data of tagging experiments for estimating one of the essential constants. Alternative procedures which will not require tagging data seem, however, to be possible of development and application. Investigations of this matter have been commenced with encouraging preliminary results. It is hoped to be able to present a practical procedure in the near future. This, of course, is a matter of particular great importance for the tuna fisheries, in the study of which the writer is primarily engaged, since there we have no tagging data of consequence, and only faint hope of obtaining in the near future an adequate measurement of exploitation rate by such means.

LITERATURE CITED

- BRANOV, F. I., 1918. On the question of the biological foundation of fisheries. (In Russian) *Nauchnyi issledovatel' skii ikhtologicheskii institut, Izvestia*, vol. 1, no. 1, pp. 81-128.
- BERTON, R. J. H., 1953. Some observations on the principles of fishery regulation. *Jour. du Cons.*, vol. 19, no. 1, pp. 56-68.
- CKMANN, A., 1938. *Über den Hochstertrag der Fischerei und die Gesetze Organischen Wachstums*. Ber. Deutsch. Wiss. Komm. f. Meeresforschung, N. F., Bd. 9, Hft. 1, pp. 1-47.
- seil Permanent pour l'Exploration de la Mer.
1948. Scientific meeting on the effect of the war on the stocks of commercial food fishes, Friday, 24th October, 1947. *Cons. Perm. Int. Explor. Mer, Rapp et Proc. Verb.* vol. 122, 62 pp.
- NLOP, H. A. and F. H. Bell, 1952. New problems in regulation of Pacific halibut stocks. *Jour. du Cons.*, vol. 18, no. 2, pp. 165-171.
- STANG, W., 1900. The impoverishment of the sea. *Jour. Mar. Biol. Assoc. Un. Kingdom*, N. S., vol. 6, no. 1, pp. 1-69.
- THAM, M., 1935. Modern theory of exploiting a fishery, and application to North Sea trawling. *Jour. du Cons.*, vol. 10, no. 3, pp. 264-274.
1939. The sigmoid curve and the overfishing problem. *Cons. Int. Expl. Mer, Rapp et Proc. Verb.*, vol. 110, pp. 17-20.
1953. Overfishing and optimum fishing. *Cons. Int. Expl. Mer, Rapp et Proc. Verb.*, vol. 132, pp. 72-78.
- RT, JOHAN, GUNNAR, JOHN and PER OTTESTAD, 1933. The optimum Catch. *Hvalradets Skrifter*, Nr. 7, pp. 92-127.
- UTSMAN, A. G., 1953. Fishery management and research. *Jour. du Cons.*, vol. 19, no. 1, pp. 44-55.
- ENTOSH, W. C., 1899. *The resources of the sea*. C. J. Cloy and Sons, London, 248 pp.
- ARISH, B.B. and R. JONES, 1953. The state of the haddock stocks in the North Sea 1946-50 and at Faroe 1914-50. *Scottish Home Department, Marine Research* 1952, no. 4, pp. 1-27.
- CKER, W. E., 1944. Further notes on fishing mortality and effort Copeia. 1944, no. 1, pp. 23-44.
- USELL, E. S., 1931. Some theoretical considerations on the "overfishing" problem. *Jour. du Cons.*, vol. 6, no. 1, pp. 3-20.
1939. An elementary treatment of the overfishing problem. *Cons. Perm. Int. Expl. Mer, Rapp et Proc. Verb.*, vol. 110, pp. 7-14.
1942. *The overfishing problem*. Cambridge University Press, London, 128 pp.
- MAEFER, MILNER B., 1954. Some aspects of the dynamics of populations important to

- the management of the commercial marine fisheries. Inter American Tropical Tuna Commission, Bulletin, Vol. 1, no. 2, pp. 25-56.
- THOMPSON, W. F., 1950. The effect of fishing on stocks of halibut in the Pacific. University of Washington Press, Seattle, 1950, 60 pp.
1952. Condition of stocks of halibut in the Pacific. Jour. du Cons., vol. 18, no. 2, pp. 141-166.
- THOMPSON, W. F. and F. H. Bell, 1934. Biological studies of the Pacific halibut fishery (2). Effect of changes in intensity upon yield and yield per unit of gear. Rept. Int. Fish. Comm., no. 8, 49 pp.

Changing Concepts In Fishery Research On the Great Lakes

RALPH HILE

Fish and Wildlife Service, Ann Arbor, Michigan

It must seem illogical to approach the subject of accomplishments of fishery biology on the Great Lakes by detailing certain weaknesses of earlier researchers and points of view. Yet the paradox may not be as grievous as would appear. Surely we may count it an accomplishment to have become aware of defects both in our way of doing and of thinking and to have made a start toward the development of new lines of attack which we feel will make our future efforts more productive.

Before undertaking the painful specification of past shortcomings, let us digress momentarily to give a minimal background on the Great Lakes and their fisheries.¹ The five lakes have a combined surface area of 95,000 square miles—61,000 within U. S. boundaries and 34,000 under Canadian jurisdiction. The U. S. waters of the Great Lakes are shared among eight states, each of which has full jurisdiction over the fisheries within its boundaries. Thus we have altogether nine fishery codes.

Ecological conditions vary widely both between and within lakes — often in contiguous waters. We know, for example, that within the relatively limited confines of an area as small as Green Bay — only 118 miles long and at most 23 miles wide — the life histories of certain shallow-water species differ greatly between the northern and southern ends. It is these highly variable shallow waters that are most productive. This same Green Bay, for example, has contributed 60 to 70 per cent of Lake Michigan's total production in recent years. Only the deeper waters of the three upper lakes and Lake Ontario offer anything even approaching the degree of uniformity and stability of habitat encountered in the open sea.

Commercial production of fish in the Great Lakes is relatively small — characteristically 70 to 80 million pounds in U. S. waters in recent decades — but is economically important. As an illustration, the dollar value of Great Lakes production equalled that of the Pacific sardine when that fishery was at its height. The lakes are without large fishing ports; the catches are

1 For accounts of the Great Lakes fisheries at various periods see: Milner (1874); Smith and Snell (1891); Rathbun and Wakeham (1897); Koelz (1926). Gallagher and Van Oosten (1943) gave considerable historical information on the fisheries, offered detailed discussions of problems of regulation, and published all available records of production through 1940. Van Oosten (1938) wrote a historical sketch with special references to State of Michigan waters.

ed at hundreds of points scattered along the nearly 5,000 miles of U. S. e-line.

incipal gears are gill nets (almost always fished on the bottom and never ed) and various types of impounding nets. Most fisheries are composite, at several species are taken simultaneously and most species are taken in ity by several kinds of gear; this circumstance has forced the develop- t of special procedures for the estimation of availability and fishing ure.³

ne complexity of situation indicated by these sketchy comments played portant role in the framing of past biological investigations of the Fish Wildlife Service and inevitably must loom large in the development of e research plans. Confronted by scanty and fluctuating budgets the ce took the only approach really open — studies of individual com- ally important species and fisheries based on them in single lakes or ns of lakes. Even here the selection was more by circumstance than by r for materials were collected as opportunity presented itself during the e of practical studies — mostly on gear selectivity³ — of sufficient icy to attract outside support from State and other agencies.

is haphazard approach was not as unproductive as might have been ipated. Numerous sound, and a few substantial, pieces of work were leted and a large amount of fundamental information was accumulated. we are in the anomalous situation of the property owner who has derable building material scattered about his lot—has even made a on construction—but still is living in a tent.⁴

is to be suspected also that the necessity of placing first one fish and another under our scientific scrutiny may have betrayed us into mplication of the problem of productivity. The typical history of ction in the Great Lakes has included an initial period of relatively output dominated by first-choice species as lake trout and whitefish, ized by a progressive deterioration in which the production of the valuable s declined and less and less desirable varieties as freshwater drum, rs, and carp became more prominent in the catch. At times this oration reaches the point that total production is controlled by the t for "rough" fish.

e sequence—reduced production of one after another choice species ed by increased take of less desirable varieties—was given the interpreta- ooth common and generally acceptable at the time. It was depletion gh overfishing in the simplest classical sense—removal of the stock at a aster than it could replace itself. First one species or group of species epleted; then the fishermen turned to another and the process was ed until, as a result of the successive, largely independent declines, the ard was bare except for the neglected varieties of lowest quality.

W, none of us engaged in the earlier research on the Great Lakes is or a biologist as to believe that different species of fish do not affect

descriptions of procedures employed for the analysis of Great Lakes fishery statistics see: il (1937); Hile and Jobes (1941); Van Oosten, Hile, and Jobes (1946).

oosten (1932, 1933, and 1935) described and gave summaries of findings for some ese pioneering studies of savings gear.

e Hile (1952a) for a historical review of Federal research on the Great Lakes fisheries.

each other. Yet the conviction that the importance of these interactions among species was negligible in comparison with the direct depleting effect of unwise fishing was implicit, if not always stated, in the pronouncements of the period. Warnings as to the impending collapse of the fisheries stressed always the growing scarcity of individual species through the simple mechanics of too rapid removal. The mere fact of declining take came to be accepted as *prima facie* evidence of overfishing to be corrected or through restrictions.

The regulatory measures recommended were designed to correct a simple imbalance between rate of recruitment and rate of exploitation—reduction of fishing intensity through higher size limits, closed seasons and ground restrictive specifications on gear (principally in the form of larger meshes). Given sufficiently drastic restrictions, it was argued, the fishery surely could be saved from almost certain doom, and most probably much of its former productivity restored.

We arrive now at the matter of changing concepts. Briefly stated, the accumulation of new information and the re-appraisal of old are forcing upon us the realization that the cause of deteriorated fisheries in the Great Lakes and hence the means for their improvement, do not offer a problem as simple as has been supposed. It is not suggested that over-fishing in the strict sense has not taken place, or that regulations past and present have been useless. As recently as the early and middle 1930's we saw the destruction of stocks of whitefish in Lake Huron that almost surely could have been prevented or lessened by the adoption of relatively simple restrictions (Van Oosten, Hile, and Jobs 1946), and bad as conditions are now they might be far worse in some fisheries but for restrictive measures in effect. On the other hand, we do know that the imposition of restrictions has not been generally effective in restoring productivity and that on occasion overzealous protection has all but put an end to potentially productive fisheries.⁵

Our principal departure from earlier thought concerns not so much the cause of the deterioration of the fisheries as the process whereby the change has come about. Although we concede readily the importance of such factors as the deposition at various periods of sawdust, bark, and silt, the pollution from varied industrial and domestic wastes, the fertilizing effects of sewage effluents and drainage from agricultural lands, and disruptions from introductions of exotic species of fish, we must still consider fishing activity the principal cause of the decline of the fisheries. There is a good reason to suspect, however, that in the mixed stocks of our shallow-water areas: "... a major effect of fishing lies in the disturbance of ecological relations among the fishes. Thus, fishing pressure to which the species are subjected in common may give one a competitive advantage and place another at disadvantage. Differences of fecundity, growth, and longevity, . . . then lead to a particular species composition at one level of intensity may bring about a greatly different composition at another. Changes of this order can be accentuated if fishing pressures, relative to the actual stock, differ from species to species. Furthermore, the generally lower level of commercial

5 A good illustration of this point is provided by studies still in progress on the yellow perch of southern Green Bay (Hile 1953). Here, the evidence indicated that production was limited by the inability of most individuals in the slowly growing stock to survive the more than five years required to attain the minimum legal length of eight inches. The effects of a reduction of the size limit to 7½ inches are now being studied.

production in the modern period suggests the possibility that fishing pressure on commercially exploited species may have operated so much to the advantage of the smaller, non-commercial species that the latter now make up an increased percentage of the total biological production.”⁶ In brief, we hold that fishermen did not turn from declining first-choice fish to exploitation of a pre-existing stock of cheaper fish but rather that through ecological changes the poorer fish became more plentiful as the better ones grew scarce. We question whether the biological production of fish ever has declined significantly in the Great Lakes; on the contrary the fertility of the lakes probably has increased with the rise of human population.

Although the general increase in the percentage of cheaper fish in the commercial take leaves little doubt that fishing has been on the whole injudicious to the welfare of first-choice varieties, certain outstanding exceptions preclude the assumption that we have a simple case of selective fishing against the better species. In some areas the changes in ecological conditions seem to have operated for the betterment, not to the detriment, of first-choice fish. A striking example comes from the Michigan waters of Green Bay where the 1929-1949 average annual production of whitefish, a high-priced species always in market demand and fished intensively, was 2½ times the average take in the early fishery of 1891-1908 (Hile, Lunger, and Buettner 1953). Similarly, in Lake Erie the catch of the highly prized walleye, fished intensively without benefit of a closed season during spawning and at a size limit a full two inches below that recommended 20 years ago, has shown a strong upward trend of production during nearly all of these past 20 years—a trend that has carried the take to unprecedented high levels.⁷

Thus, our problem is complex indeed. It is one that calls for study of populations of fish rather than of individual species. We need most to understand interactions among species and how they are affected by changing environmental conditions. In this situation we see little prospect for an approach toward sounder management for higher productivity through the application of fishing theory as developed among others by Baranov, Russell, Graham, and Beverton in Europe, by Thompson, Ricker, and Schaefer in North America, and as applied so brilliantly by some of them toward the solution of fishery problems. This is not to imply that our particular species are exempt from the laws of nature—that rates of growth, natural mortality, recruitment, and exploitation are not primary determinants of yield. Rather, these factors do not behave in our fish stocks in a fashion which must be assumed in a model population if one is to arrive at equations for which there is any chance of obtaining even approximate solutions. True, fishing theory has grown to accept the idea of a certain fluctuation of rates rather than rates of exploitation, has recognized possible interactions among these rates, and to some extent has made adjustments for them. Also, the importance of hydrographic and other environmental conditions in the

⁶From Hile, Lunger, and Buettner (1953).

⁷Callagher and Van Oosten (1943) considered the 1885-1908 average annual production of 949,000 pounds of walleyes to be the “normal” take for U. S. waters of Lake Erie. After the catch declined and averaged only 1,418 pounds or 73 per cent of normal in 1912-1935. Now sharply the trend has been upward during the last 20 years is demonstrated by the following 5-year averages: 1933-1937—2,001,000 pounds; 1938-1942—3,531,000 pounds; 1943-1947—4,434,000 pounds; 1948-1952—5,126,000 pounds.

determination of abundance has long been generally recognized. Nevertheless, the validity of mean rates—perhaps more properly typical rates—and the concept of factors operating within a largely independent, self-contained stock is implicit in and essential to the theory.

Our stocks of fish in the Great Lakes clearly do not meet the conditions that must hold if fishing theory is to be the basis of management.⁸ Not only do we have constantly growing evidence that extrinsic factors by far overshadow intrinsic factors in the determination of availability of a particular stock; it is apparent also that in some stocks the fluctuations are of such a magnitude as to make management on the basis of mean or typical rates out of the question. Time does not permit a detailing of evidence in support of these statements. From historical records we do know that species once plentiful are now scarce and species once scarce are now dominant.⁹ During the periods of our own researches we have seen enormous and sudden changes of availability and species composition which, though they may possibly be related to previous fishing activities are not to be explained sensibly, at least in quantitative terms, by any theory as yet formulated.¹⁰ Although we have used and propose to use the most exacting analytical procedures available to us and within our capabilities, our central problem is not one of vital statistics. Rather, it is a problem of biological understanding. We must learn the causes of or at least the conditions that permit or accompany the great fluctuations that occur; we must understand better how fluctuations

8 But for the fact that the stocks of lake trout have all but disappeared from Lake Huron and Lake Michigan and are dwindling so rapidly in Lake Superior that early collapse of the fishery threatens (Lakes Ontario and Erie have never been important centers of lake trout production), we should need to make a possible exception for that species. Ecological conditions in the deeper waters inhabited by the lake trout are far simpler and more stable than those in the shallower areas. Here the lake trout has existed as the principal predator on large stocks of small species of coregonids (ciscoes or chubs) and of cottids and sticklebacks. The only other species of similar predatory habits (and one equally vulnerable to the sea lamprey), the burbot, has been much less abundant. This relatively steady environment and simplicity of interspecies relationships, together with the long life of the lake trout and the normal dependence of the fishery on a considerable range of age groups, led to a high degree of stability. Although the production and availability of lake trout have exhibited both long-term and cyclic trends (Hile 1949; Hile, Eschmeyer, and Lunger 1951a, b), the fishery has in general lacked the sudden, wide fluctuations characteristic of the fisheries for so many Great Lakes species. Despite the fact that the point has not been tested, we suspect that the application of fishing theory to the lake trout fishery would have been profitable.

9 Smith and Snell's (1891) comprehensive port-by-port account of the Great Lakes fisheries in 1885 makes possible many instructive comparisons of early with present-day conditions. Valuable also are their descriptions of changes in species composition that had recently occurred or were taking place at the time of their survey. Their following comment (p. 116) on the fishery of Oconto County, Wisconsin, for example, gives evidence that the present strong dominance of the yellow perch in southern Green Bay was in the process of establishment in the 1880's: "While the whitefish and the pike have been disappearing the perch have become enormously more abundant. Before 1882 only a few scattered ones were obtained, averaging about six to each lift of the pound net. Since then they have become more and more numerous each year, until in the spring of 1885 never less than 50 pounds and sometimes as much as a ton of them were taken at a lift."

10 A recent example of these tremendous fluctuations is provided by the 1943 year classes of three species in northern Green Bay, Lake Michigan (Hile 1950; Hile, Lunger, and Buettner 1953) so strong as to lead to a modern high in the production of lake herring and to all-time records in the output of whitefish and walleyes. Although the analysis of data on the walleye remains to be completed, the preliminary estimate that the contribution of the 1943 year class to the commercial fishery will be 50 to 60 times the average of year classes for the preceding 10-15 years is in no way excessive.

one species affect another; we must learn more of the role of meteorological and hydrographic factors; and, of course, even though the application may be by equation and formula, we must study carefully the effects of fishing.

In situations as intricate as those in most of our Great Lakes fisheries, we must approach understanding through a series of approximations. Precision in our statements relative to changes in populations will come slowly. We count it unlikely that in our time we shall be in position to recommend changes of management procedures with full confidence as to the extent or in the direction of their effects. We expect nevertheless to recommend changes of regulation which, according to our best knowledge, give promise of being beneficial and to check carefully to determine their actual effects. Improvements in the regulation and management of the Great Lakes fisheries must come through experimentation rather than deduction. The function of the biologist will be that of furthering maximum efficiency in the experimental process.¹¹

The principal accomplishment of fishery biology in the Great Lakes, to date, has been to teach us that for more effective understanding we must focus our attention on how fish live together in a constantly changing environment. Circumstances may require that we study species individually, and we can never achieve the goal of simultaneous research on every variety in a single regulation; but we must never think in terms of one species alone, for it does not live alone.

This statement of changing outlook carries no admission that our past efforts have been futile: rather it is an expression of hope that our future programs will be more effective. We envision no great change in our methods of research. We shall continue to count and measure fish, read otoliths, examine stomachs, analyze statistics of production, intensity, and catch per unit effort. We trust only that we can schedule our operations more sensibly and piece together our information to form a more comprehensible picture.

LITERATURE CITED

- LAGHER, HUBERT R., and JOHN VAN OOSTEN, 1943. Supplemental report of the United States members of the International Board of Inquiry for the Great Lakes Fisheries. Internat. Bd. Inq. Great Lakes Fish., and Suppl., pp. 25-213.
- LEWIS, RALPH, 1937. The increase in the abundance of the yellow pike-perch, *Stizostedion vitreum* (Mitchell), in Lakes Huron and Michigan, in relation to the artificial propagation of the species. Trans. Am. Fish. Soc., Vol. 66 (1936), pp. 143-159.
- , 1949. Trends in the lake trout fishery of Lake Huron through 1946. Trans. Am. Fish. Soc., Vol. 76 (1946), pp. 121-147.
- , 1950. Green Bay walleyes—a report on the scientific investigation of the marked increase in abundance of walleyes in Green Bay. The Fisherman, Vol. 18, No. 3, pp. 5-6.
- , 1952a. 25 years of Federal fishery research on the Great Lakes. U. S. Fish and Wildlife Serv., Spec. Sci. Rep.: Fish. No. 85, 48 pp.
- , 1952b. Fishing regulations. The Fisherman, Vol. 20, No. 3, pp. 5, 12, and 14.
- , 1953. Perch studies in Green Bay. (In the series: Dividends from research.) Prog. Fish-Cult., Vol. 15, No. 3, pp. 133-134.
- LEWIS, RALPH, PAUL H. ESCHMEYER, and GEORGE F. LUNGER, 1951a. Decline of the lake trout fishery in Lake Michigan. Fish. Bull. U. S. Fish and Wildlife Serv., Vol. 52, pp. 77-95.
- , 1951b. Status of the lake trout fishery in Lake Superior. Trans. Am. Fish. Soc., Vol. 80 (1950), pp. 278-312.

See Hile (1952b) for a recent discussion of problems of regulation of the Great Lakes fisheries.

- HILE, RALPH, and FRANK W. JOBES, 1941. *Age, growth, and production of the yellow perch, Perca flavescens (Mitchell), of Saginaw Bay.* Trans. Am. Fish. Soc., Vol. 70 (1940), pp. 102-122.
- HILE, RALPH, GEORGE F. LUNGER, and HOWARD J. BUETTNER, 1953. *Fluctuations in the fisheries of State of Michigan waters of Green Bay.* Fish. Bull. U. S. Fish and Wildlife Serv., Vol. 54, pp. 1-34.
- KOELZ, WALTER, 1926. *Fishing industry of the Great Lakes.* Rep. U. S. Comm. Fish. for 1925, pp. 553-617.
- MILNER, JAMES W., 1874. *Report on the fisheries of the Great Lakes; the result of inquiries prosecuted in 1871 and 1872.* App. Rep. U. S. Comm. Fish. for 1872 and 1873, pp. 1-78.
- RATHBUN, RICHARD, and WM. WAKEHAM, 1897. *Report of the Joint Commission relative to the preservation of the fisheries in waters contiguous to the United States and Canada.* House of Representatives, 54th Congress, Second Session, Doc. No. 315, 178 pp.
- SMITH, HUGH M., and MERWIN-MARIE SNELL, 1891. *Review of the fisheries of the Great Lakes in 1885, with introduction and description of fishing vessels and boats by J. W. Collins.* App. Rep. U. S. Comm. Fish. for 1887, pp. 1-333.
- VAN OOSTEN, JOHN, 1932. *Experiments on the mesh of trapnets and legislation of the commercial fisheries of Lake Erie.* Trans. Am. Fish. Soc., Vol. 62, pp. 100-107.
1933. *Preliminary report on investigation of chubnet meshes in Lake Michigan.* The Fisherman, Vol. 2, No. 4, pp. 3-4 and 8.
1935. *Logically justified deductions concerning the Great Lakes fisheries exploded by scientific research.* Trans. Am. Fish. Soc., Vol. 65, pp. 71-75.
1938. *Michigan's commercial fisheries of the Great Lakes.* Mich. History Magazine, Vol. 22, pp. 3-39.
- VAN OOSTEN, JOHN, RALPH HILE, and FRANK W. JOBES, 1946. *The whitefish fishery of Lakes Huron and Michigan with special reference to the deep-trap-net fishery.* Fish. Bull. U. S. Fish and Wildlife Serv., Vol. 50, pp. 297-394.

Half a Century of Fishery Biology In Europe

MICHAEL GRAHAM

Fisheries Laboratory, Lowestoft, England

At the invitation of the King of Sweden, representatives of several Governments met on 15th June, 1899, in Stockholm. The countries represented were Denmark, Norway, Sweden, Germany, Great Britain, the Netherlands and Russia. They wished to join in studying the seas: the hydrography especially in relation to fisheries, the fisheries themselves, and the biology of the various species of fish.

During the century that was just ending there had been some half dozen pioneers into these subjects. Victor Hensen had conceived the possibility of evaluating the production of the sea by sampling with plankton nets (Hensen, 1911). Frank Buckland had devoted a life's work to the conception of managing fresh water fisheries according to their natural history.* T. W. Fulton (1897) had started to relate hydrographical studies to the facts of the commercial fisheries. E. W. L. Holt (1893) had done the same for biological studies, and had advocated remedial measures for the North Sea plaice. Particularly eminent among these pioneers was C. G. J. Petersen (1894) who had correctly appraised the problem of rational exploitation of a fishery, and had also demonstrated the possibilities of transplantation to areas with a rich bottom fauna. On the hydrographical side, Otto Pettersson had sketched the possibility of relating fluctuations in fisheries to astronomical phenomena through hydrographical effects, and so of foretelling them (1899). Frijof Nansen (Holland-Nansen and Nansen, 1909) had begun the study of water masses, and Martin Knudsen (1899) the chemical and physical characteristics

*See, eg., Graham, 1948

of sea water. These names may serve to indicate the kind of discoveries that had already been made when the conference met in 1899. It is not claimed that everybody important in that period has been mentioned.

The requirements seen by the delegates at the Stockholm conference stand out as three. There was considerable need for improvement and standardization of methods, especially in hydrography. Next, the delegates evidently thought that the isolated workers had not yet given sufficiently full descriptions either of the hydrography or of the biology of fisheries, and they planned a very full program of observations at sea. Thirdly, they considered that the time had come, or was coming very soon, for international regulation of the fisheries in the general interest, and they saw the need of joint consideration and discussion of the best means for bringing this about.

We can relate those requirements to two aims. For the great fisheries, especially those in northern waters, the delegates saw reason to believe that a study of the hydrography would advance the efficiency of the fishing. For the hard-fished North Sea and for similar waters, they saw a fair prospect of introducing more profitable fishing by agreement between governments.

At Stockholm, Sir John Murray thought that, "within the last 50 years the civilized nations of the earth have been raised to a higher plane of intellectual progress than that on which humanity before proceeded"; and that civilized people were outgrowing the stage of thought where seas and mountains fortuitously made enemies of nations who otherwise would be friendly and cooperative.

The spirit of the conference, and of the two that followed it, was optimistic. At the inaugural conference of the *Conseil International pour l'Exploration de la Mer* in Copenhagen in 1902, the Danish delegate, Captain C. F. Drechsel, said that he was sure that when the Conseil was constituted there would be results of importance for the fishing industry.

The authority from which the early history of the International Council can most conveniently be gathered is that of the Jubilee Report published in 1928, covering the period 1902-1927. The same volume gives an adequate account of the research effort and equipment made by each country to fulfill its undertakings at the meetings of 1902 and 1903, at the first of which Finland had joined, and at the second of which Belgium was also represented. In 1912, France and the United States also joined, but the United States and Russia did not resume participation after the first World War. Portugal joined in 1922, Poland in 1923, Spain in 1924, and Ireland in 1925.

In the dozen years or so that were allowed to them before the first World War interrupted their activities, the scientists under the Council did a great deal of work. On the hydrographical side their achievements were both necessary and new. They standardized the methods for determining salinity and temperature by which the main water masses could be described. On the biological side, however, the work at the beginning of the century does not, at the present day, appear to represent substantial advances on the conceptions of the pioneers of the previous century. Two exceptions may be made.

The first exception was the study of fluctuations, associated particularly with the name of Johan Hjort and his fellow workers in Norway, which emphasizes the fact that the success or failure of most broods of most species of fish is determined very early in their history, so that a rich or poor brood can be designated as such either before it enters the commercial fishery or just after-

wards. This discovery has been the basis of forecasting fisheries in many countries. The demonstration depended on methods of age determination by scales or similar structures, which often had clearly marked on them a number of zones corresponding to the years of life of the fish. The year-rings had been discovered before the Council was established, but the Council helped to finance the Norwegian workers who made the method applicable to herrings and cod (Hjort, 1914).

The second exception that could be made would be in favour of Buchanan-Wollaston's work in applying Hensen's conception of evaluating marine production, including that of the demersal fishes, to the plaice of the southern North Sea (Buchanan-Wollaston, 1923). Hensen and Apstein (1897) had not succeeded in making a satisfactory quantitative estimate for the winter spawning fishes in the North Sea. It remained for Wollaston to devise new ways of treating the data, from an adequate number of cruises using Hensen's net, which he did successfully.

For the rest we must notice the marking of fish on a prodigious scale, which served to confirm and elaborate the knowledge from earlier markings; and detailed descriptions of the hydrography of various regions: in general, a conscientious filling in and confirmation of the discoveries made by men of genius in the previous century. The confirmation of the high recapture rate of marked fish has proved of great propaganda value, and, in general, doubtful minds were sustained by the masses of data that were produced; but it might be argued that in no other way were the aims of relating hydrography to fisheries or of understanding and introducing rational fishing brought nearer in 1914 than they were in 1899. Indeed, the emphasis on fluctuations in brood strength, which do not in fact reduce the importance of the other two problems, served as a distraction.

Two recommendations did come from the studies in the period before 1914. The first was that an extensive area should be closed on the continental coast as a nursery for plaice in the North Sea (Holt's proposal, 1893), and the second was that there should be large-scale transplantation of small plaice from the crowded nursery areas to the rich feeding grounds of the Dogger Bank. Neither recommendation has been applied internationally as yet.

In most countries, fishery research ceased during the war of 1914-1918. At the end of that war, however, it was plain for everybody to see that the contention of the scientists was amply justified, that fishing controlled the weight of the stock of demersal fish in areas such as the North Sea. The stock in 1919 was very much heavier than it had been in 1913, manifestly as a result of the reduction of fishing to a small fraction of what had taken place formerly. The question was indeed asked, whether this increase could be due to natural fluctuation in brood strength, and there had, in fact, been a favorable fluctuation of haddock in 1913. It was however forcibly pointed out by "Quibbon," a writer in *The Fish Trades Gazette*, that nobody had previously heard of three species enjoying a great positive fluctuation simultaneously: cod, haddock, and plaice. The evidence after the war of 1939-1945 proved even more telling (Cons. Int. Explor. Mer. Rapp. et Proc. Verb. 132).

The Jubilee Volume of 1928 records research done between 1919 and 1927, some of which is a little more inspiring than what had preceded the first World War, and for which the painstaking studies of the earlier periods may be given some credit, because they provided a background of general and of

particular information. For example, the determination of temperature and salinity was standardized in the earlier period; the life-history of several important species became known in sufficient detail; and the larval stages of nearly all species of fish were described so well that they could easily be recognized. As hydrographical methods no longer constituted a problem, E. le Danois was able to extend his imagination to the effect of fluctuations — "transgressions" as he called them — in the North Atlantic water, as they affected the fisheries on the coasts of Europe. Without claiming that his ideas were valid in all respects, we may recognize his as an attempt to reach that understanding of fishery hydrography which was aimed at by the founders of the International Council.

The detailed studies of the larvae of various fish had led Johannes Schmidt to fix his attention on the Leptocephali of eels, and thence to his classical discovery of the main spawning ground for European eels in the region of the Sargasso Sea, from which the larvae drift towards the coasts of Europe, naturally impinging in greatest numbers on the western seaboard. This discovery, that the source of all their eels was far to the westward, led some German workers to the practical idea of transplanting elvers from places where they arrived in enormous numbers, such as Epney on the estuary of the River Severn, to inland waters in north Europe, which the eels did not naturally reach so easily. It can be said that in this curious way the International Council was instrumental for the first time in raising the yield of a fishery. How soon the same result would have been achieved without the existence of the International Council is a question on which it is idle to speculate.

Although the Jubilee Volume of 1928 contains several other matters of technical interest, the reader will find it difficult to discern anything definite, apart from the theory of le Danois and the transplantation of the eels, that could be classed as an important advance either in fishery biology or in its practical application. The first 25 years of the International Council formed, certainly, a period of promise on the original aims of the Council, but there was precious little that an outsider would recognize as performance.

From the Norwegian work on brood strength, the first quarter century did see the establishment of forecasting of fisheries, of which Harold Thompson's work on the haddock (1930) and W. C. Hodgson's on the herring (1932) may be mentioned, although neither receives very much emphasis in the Jubilee Volume. Both have continued successfully until modern times, and the Council must certainly be given credit for discernment in financing the work in Norway on which this method of forecasting was based.

The picture changes in the second quarter century, beginning in 1928, because then the main aims of the Council began to be realized, although in this period too there was necessarily a great deal of work which could be described as promising for the future rather than as of important practical application, or as representing a major advance of knowledge.

Perhaps it will be best to deal with this promising work first and then deal later on with the lines of research that can be said to have arrived.

Part II of the second Jubilee Volume of the International Council is constructed as a review and guide, in eight subjects considered to be of major interest. In addition, we may consider the report on fisheries hydrography published in 1952, making a ninth subject for consideration in the present history. Of the nine subjects, four may be considered as having arrived. Nothing derogatory is intended in this distinction: it refers merely to the

original aims of the Council, judging the contributions on the rather strict basis of whether a critical layman could agree that the research work in question had or had not yet contributed to the fulfillment of those aims.

The first subject to consider is called "The Milieu," which is a perhaps not too happy name for general hydrography in a wide sense, but excluding the cycle of nutrient salts. The paper in the Jubilee Volume serves as an informative catalogue to a prodigious bulk of work describing the movements and temperature and salinity of water masses in the North Atlantic and in its dependent seas. In addition, it gives considerable space to the outstanding advance in knowledge and understanding of submarine illumination that had taken place during the period under review.

Quite outstanding also, has been the advance in knowledge of the cycle of nutrient salts, including the carbon dioxide system, which receives full and excellent treatment in another paper of the volume.

The second paper in the volume reviews the progress of knowledge and understanding of the plankton, which has used a great proportion of research effort ever since the start of the Council, and which continues to be judged, probably rightly, as likely to yield understanding of many practical problems in fisheries. Indeed, here and there, knowledge of plankton has nearly or quite arrived at this stage. Cushing (1953) appears to be on the point of making the current fate of patches of *Calanus* a guide to the fishermen for herrings in the North Sea during the summer; and it must not be overlooked that Russell's diagnosis, with the aid of species of *Sagitta*, that the water of the English Channel off Plymouth has in recent years been less productive than formerly, appears to provide a warning to owners of herring drifters not to attempt a revival of the winter herring fishery in that area. The proof of the practicability of this argument will come when *Sagitta elegans* again becomes abundant in the English Channel—if a herring fishery is then successfully revived. There is still a strong belief that in many fisheries the detection of indicator plankton organisms may be of practical importance to fishermen.

It is interesting that the marking of fish, which almost always arouses the interest of fishermen, does not by itself appear to achieve the classification of being already of value to them. Marking plays an important part, but it does so indirectly, because of its information about overfishing, which will be dealt with under the second group of studies. In the meanwhile we must pass by the half million fish that have been marked by the member countries of the International Council in the recent quarter century, noting only how fascinating it is to see charts of migrations of marked herring between northern Iceland and southern Norway, or of marked cod extending via Greenland and Iceland from Newfoundland to the Faroe Islands. Mention too must be made of salmon migrating between Scotland and southern Norway, and between northern Norway and the north coast of Russia.

When we consider the record reviewed so far, it is interesting to speculate on whether some of our fore-runners would have found the slowness of the progress, combined with such a prodigious amount of work, on the whole irritating, or whether they would have been satisfied. Would Buckland, Hensen, Petersen, and Nansen have been pleased? Personally, I am not at all sure that they would. When, however, we turn to the five remaining subjects, I think that we could be more confident that we would receive some praise from the pioneers, although I should think poorly of them if they

did not find much to criticize in the halting and hesitating manner in which we have fulfilled some of their original conceptions.

I can imagine, for example, that Frank Buckland would have been pleased at the evidence given in the second jubilee volume of numerous applications here and there of scientific knowledge to the conduct of the fishing industry or to the formation of policy. In a first category are noted investigations of fishing methods, use of aids to find fish, information on the occurrence of fish, including the establishment of new fishing grounds, and forecasts of the yields of various fisheries. On applications to policy, it is noted that this is a slow process, but the Baltic fisheries were the subject of a Convention in 1929, those of the Transition Area (Skagerrak, Kattegat and Belts Seas) of a Convention in 1937, and the crustaceans of the Skagerrak and Kattegat were protected by the Convention of 1951. The discoveries made under the Council had also influenced some actions by individual countries, and had contributed some of the knowledge necessary to the setting up of the International Whaling Commission. The principal activity, however, that might have commended itself to Frank Buckland was that leading to the Conventions that attempt to introduce more rational fishing in the North Sea. The Convention of 1937 introduced regulations of the meshes of fishing nets, along with size limits for several important species of fish, and the Convention of 1946 raised the figures to levels that should, if all goes well, after its introduction in 1954, result in appreciably better fishing of the important species the haddock as well as of hake and sole.

Hensen would surely approve of the extent to which his method of evaluating a fish stock, by estimating the total number of eggs, and thence the number of spawning females, has become established as an important part of the evaluation of the stock of plaice in the southern North Sea. Ordinary observations of length and weight on fish markets can establish the number of fish landed, and the ratio of spawning females to the total catch. Hensen's method, as developed by Buchanan-Wollaston, allows an estimate of the number of spawning females in the sea. It is a small step to estimate the total number of plaice of fishable size in the sea, applying the ratio found on the fish markets. We then have an estimate of the stock of fish, and of the catch, and so of the rate of fishing. This is an invaluable check on independent estimates, made either from marking experiments or from observations under widely different rates of fishing, such as became available owing to the second world war.

I think that we could reasonably expect Nansen to have been pleased with the progress in the study of the water masses in the northern seas and of their effects on the fisheries. The Council meeting in 1951, the year before the Jubilee, had included a paper by Devold (1952) in which he showed, in the wide area of sea between Iceland, Jan Mayen, and Norway, that vast populations of herring were located on the borders of Atlantic and polar water. When this border shifted so did the herring. Further details may be gleaned by study of the original paper. In the report of the same meeting, a paper by A. J. Lee (1952) describes how the English "Arctic team" discovered that the concentrations of cod in May/June, October, November, and December, off Bear Island, tend to be strictly located on the border of Atlantic or Arctic type water. West of Bear Island the cod in those months are found in concentrations along the boundary between the Atlantic water of the West Spitzbergen Current and the mixed water of the Bear Island shelf, which

may be designated by the isotherm of $3\frac{3}{4}^{\circ}\text{C}$. South of Bear Island the concentration tends to be at the boundary of the mixed water and water that is more Arctic in origin, marked by the isotherm of $1\frac{3}{4}^{\circ}\text{C}$. The Norwegian herring fishery and the English cod fishery are so large in magnitude that these discoveries in fishery hydrography stand out conspicuously as beginning to fulfill one of the original aims of the International Council. The jubilee volume rightly calls attention to earlier discoveries of the same kind, referring especially to whiting in the English Channel, to the herring of the "Smalls," off the south of Ireland, and to the tunny species *Germo alalunga*. Other examples come to mind.

We may pass quickly over two subjects considered in the jubilee volume, important as they are. The first of these is the transplantation of fish, which has been conspicuously successful in Danish waters, and is still somewhat promising for the North Sea, although it has not yet been applied there internationally. The second is rather on one side from the main researches of the Council, namely the detection and recognition of fish by echo-sounding. This is established as a regular aid to several kinds of fishing, and is likely to prove of major importance permanently, both in commercial fishing and in research.

When we turn to the question of whether Petersen would have approved the progress in understanding of the problem of regulating fisheries to the best advantage (fishery management), there is doubt about the answer. In 1894 he had written, "For it cannot well be doubted that the same area of sea would be able to give a quantitatively greater profit as a constancy, when we suffered the stock of fish to be as fully developed, as in the years before the too eager fishing commenced . . . and then took exactly so much as the stock would reproduce by new growth." His participation in the work of the International Council was not very close after the year 1908, and from then onwards until his death in 1928 his name is mainly associated with investigations of bottom fauna, although he did report again on the stock of plaice (Petersen 1921). The words that I have quoted include the phrase "quantitatively greater profit." It is a conspicuous fact that this sixty-year-old enunciation of the main prize obtainable by regulation of a fishery is still a novelty to the vast majority of people who hear about fishing, and, alas, to a substantial number of those who speak about it. Instead, during the remainder of Petersen's lifetime and since his death, discussion about fishing has nearly always concerned itself with conceptions dating from the previous century, or earlier; fear of reduction in numbers of fish, or in the yield of the fishery; to be countered by this or that self-sacrificing method of protection of the fish, for the benefit of future generations of fishermen and consumers.

Petersen's paper of 1894 shows that he had correctly appreciated the relation between fishing and a stock of fish. This is a dynamic relation, with the stock tending to grow heavier all the time, and fishing tending to make it smaller, the net result, when conditions are, on the average of a series of years, stable, being no change in the weight of the stock. But there is a greater profit "as a constancy" at some levels of fishing than at others. Admittedly, many factors enter into the achievement of a profit, but for the individual fisherman the profit depends directly upon the catch per unit effort of fishing, as for example per day's absence of a standard steam trawler. However, catch per unit effort cannot be allowed to run away with policy, because the maximum catch per unit effort is at a very

low rate of effort—in the extreme case, one single fishing vessel—and hence a very low yield and total profit. Nor can yield be allowed to run away with the situation, because the maximum yield would be obtained by allowing the fish to grow to a great size, and the fishing them at that size instantaneously, which would require such a prodigious effort that there could be no profit in it. The greatest profit would come at some intermediate level of fishing, and the exact level which would be of greatest benefit to the community as a whole will not depend only on purely biological factors. The problem of fishing is therefore one of making reliable, in the sense of unbiased, estimates of effort and yield, to be expected from changes in the rate of fishing. Reading of Petersen's paper suggests that he perfectly understood the nature of this problem; reading of all other papers published before 1930 suggests that nobody else, except the Russian Baranov (1916) whose paper was overlooked, appreciated the nature of the problem.

The proper task of fishery biology, during the half century under review, can now be seen to have been the conversion into mathematical symbols of Petersen's understanding of the problem in words, and the collection of data strictly applicable to the problem. This task was begun by Russell (1931) when he expressed the tendency of the stock to increase in weight by the two symbols, A , standing for the increment due to the weight of recruits to the fishery, and G , the increment due to growth of fish during the period when they are in the fishery. He pointed out that in a steady state the sum of those must equal, quantitatively, the sum of the two other quantities, C , the weight caught by fishermen, and M , weight lost by natural mortality.

It will be seen that Russell's formulation contained two clarifications of particular importance. The first was the distinction of the stock old enough to be taken by the fishery, which he emphasized by designating a critical length of fish l . He pointed out that if one raised l by mesh regulation and size limits, one would have heavier fish comprising A and G , and so would expect to be able, other things being equal, to take a greater catch, C . The second clarification was the simple separation of the three unknown factors that required evaluation, A , G , and M .

Russell's formulation was quite self-evident, but when it was considered as an aid to guidance in making great changes in fishing and in stocks, as for example in trying to decide what level of fishing to aim at, the difficulty was immediately seen that his factors, or processes, did not remain constant at different levels of stock, but re-acted with each other. Russell himself laid stress on this difficulty, and for two or three years it seemed to render any estimates that one could make of the processes, of little use, because they could refer only to the current state of the stocks. The way out of this difficulty was fairly easy, and was found by Graham (1935), who saw that Russell's equation could be of use, not in order to decide ultimately how far one should go in regulating a fishery, but to decide the important point of whether to go towards reducing fishing or towards increasing it, compared with the present state, which could be diagnosed from existing data on values of the processes. For this purpose, however, it was necessary to re-state Russell's equation, which had been in the form of increments, in terms of instantaneous rates. It thus became a differential equation. We may note, although it is outside the terms of reference of the present paper, that Thompson and Bell (1934) had already found their own way

of using theory, essentially on Russell's lines without being hampered by Russell's difficulty.

Another way of overcoming, in theory at any rate, Russell's difficulty of the interaction of the processes, had been taken by Hjort, Jahn, and Ottestad (1933). Without separating the processes, they advanced a theory for the overall growth of a stock, which would be the net increase, with reproduction and growth positive and with natural mortality negative. Having graphed this total growth against time, the first derivative of their main function would represent what could be taken by fishing, at any given age of stock, without either increasing or decreasing it. Bearing in mind that the catch per unit effort is proportional to the stock of fish on a ground, strictly and practically so in a steady state, we perceive that the yield of a fishery in a given time is the differential coefficient of the catch per unit effort. Unfortunately, determination of the parameters of the equation of Hjort *et al.*, requires observation of very great changes in rate of fishing and of stock. The first World War had provided such changes, and Graham (1935) with considerable difficulty, used the observations that happened to result from the war to make a crude determination of the maximum yield of the North Sea fisheries. It will be seen later that, mercifully, Graham's paper of 1935 is now obsolete, but I venture to include it in this review on the ground that at least one fishery biologist had returned to the statement of the problem as correctly seen by Petersen. The Petersen emphasis on profit was re-stated by Graham, "that the benefit of efficient exploitation lies more in *economy of effort* than increase of yield, or preservation of future stocks though both of these purposes may also be served."

The full and precise formulation of the problem of fishing has had to await the reconstitution of fishery scientific staffs after the second world war. In the meanwhile, however, the International Council was not idle in this subject, but was pushing ahead in its own characteristic way. The Conventions of 1937 and 1946 have already been mentioned, and it now falls to be related how they came into being. The aim was to raise the age at first capture by mesh regulations and size limits. The special activity to promote this extended from 1929 to 1934. In the latter year the entire Council, in its committees and as a body, recommended that member governments should put such regulations into force. The idea of mesh and similar regulations was very old—the first English mesh regulations were made in the reign of Edward III.* Nevertheless, the Council had to settle two main difficulties. The first was that small fish, if thinned out, grew faster, and it might therefore be a mistake to spare their lives. This, from its nature, was a very difficult point, but at a meeting in 1932 Russell and Bückman were each able to show quantitatively that this consideration need not deter the Council. The second objection was that, however large the mesh, it is drawn so tightly while towing a trawl that there is no hole through which the fish could escape. Goodchild's experiment, reported at the meeting of 1932 by Davis, disproved this. An essential part of the investigation was Wollaston's theory (1927) of the selective action of a net, which allowed nets of different meshes to be compared correctly.

* Moore and Moore, 1903, p. 173. In 1376 parliamentary commissioners found that the net complained of had meshes of length and breadth of two thumbs. The first mesh regulation, 2½ inches, was in I Elizabeth, C.17 1558.

Several countries put into force the very moderate mesh regulation of the Convention of 1937, but some did not; and nineteen years after the Council's final recommendation, the more useful regulations agreed in 1946 are not yet in force. But that history is not part of a review of fishery biology.

Instead, fishery biology has been concerned with the dawning realization that mesh regulations, essential as they are for certain species, including haddock and hake, will not cure over-fishing. A mesh regulation should cause the stock to consist of larger fish, thus forming an inducement to harder fishing, which, by increasing the total mortality rate, would tend to reduce again the average size of the fish in the stock. Equally, a regulated fishery in which the mesh was left free could still proceed on a downward course, by successive reductions of mesh. The two kinds of regulation go hand in hand, and existing conventions have done only half the job.

Understanding of the dual nature of the problem grew rather slowly in the 12 years from 1935 to 1947, during seven of which fishery workers mainly had other matters on their minds. By 1947, however, the double aspect was realized, though it is doubtful whether, to this day, many people realize the attraction of substantial profit that Petersen saw in allowing the stock to grow heavier. The old fear motive for conservation is so traditional that it is difficult indeed to substitute encouragement for warning; to announce good news when everyone expects bad.

In the meantime, one advance was made. Bückmann (1939) and Baerends (1947) realized that there must be a different best rate of fishing for each mesh of net: ideally the one should be adapted to the other. This is an important point in the theory, and will be referred to again; but mention of these two workers is a reminder of how many in the Council's orbit have made contributions to the general body of knowledge and understanding, yet have not been mentioned in this review. Most of them, however, are referred to in one or the other of the Council's Jubilee Volumes.

To return to the theme of this paper, the close of the half-century clearly needed a full and precise formulation of the theory of fishing that all the studies had shown necessary. At the Jubilee Meeting, Beverton (1953) was able to sketch in outline his work with S. J. Holt, which unfortunately is not yet published in full. Theirs proved a very great task, especially as the decision was taken that nearly every theoretical point should be illustrated by worked examples from data. The main equation for yield was printed in the second Jubilee Volume, from which it can be seen that it takes account of the following factors: fishing mortality, natural mortality, number of recruits, age of recruitment to the fishable area, age of capture, fishable life-span, parameters of Bertalanffy's law of growth. All these have been realized as bearing on the yield of a fishery, but it has been a major operation to fit them together correctly, each bearing their proper weight.

Without the use of such an equation, no problem of "fishery management" can be said to be completely solved. With such an equation, and with data to fit it, fishery biologists will in future be able to make diagnoses that they, at least, will be able to believe in. Where data are not available, we shall know that we cannot give a full answer, but must proceed, as formerly, by giving the best advice we can on the information available.

This review must end, but a winding-up sentence would be unreal, because the subject of the review is by no means wound up. Fifty is an arbitrary number of years, and a small one.

LITERATURE CITED

- BAERENDS, G. P., 1947. *De rationeelle exploitatie van den zeevischstand, in het bijzonder van den vischstand van de Noordzee*. Versel. Med. Afd. Visscherijen, No. 36, (translated in U.S. Dept. Int. Fish and Wildlife Service, Spec. Sci. Rep. Fisheries No. 13, 1950).
- BARANOV, T. I., 1916. *On the question of the biological foundations of fisheries*. Rep. Dep. Fish. Sci. and Industr. Invest. Vol. 1 (1) Moscow.
- BEVERTON, R. J. H., 1953. Some observations on the principles of fishery regulation. *Journ. Cons. Int. Explor. Mer*, Vol. XIX, No. 1, pp. 56-68.
- BUCHANAN-WOLLASTON, H. J., 1923. The spawning of plaice in the Southern part of the North Sea in 1913-14. *Fish. Invest. Ser. II, Vol. V*, No. 2.
1927. On the Selective action of a Trawl Net with some remarks on selective action of Drift Nets. *Journ. Cons. Int. Explor. Mer*, Vol. II, No. 3, pp. 343-55.
- BUCKMANN, A., 1932. *Die Frage nach der Zweckmassigkeit des Schutzes untermassiger Fische und die Voraussetzungen für ihre Beantwortung*. *Cons. Int. Explor. Mer, Rapp. et Proc. Verb.* LXXX, VII.
1939. Einige methodologische Folgerungen aus den deutschen Schollenuntersuchungen in der Nordee. *Cons. Int. Explor. Mer, Rap. et Proc. Verb.* 110, pp. 21-30.
- CUSHING, D. H., 1953. Studies on plankton populations. *Journ. Cons. Int. Explor. Mer*, Vol. XIX, No. 1, pp. 3-22.
- DAVIS, F. M., 1934. A mesh experiment indicating that small fish escape while the trawl is being towed. *Cons. Int. Explor. Mer, Rapp. et Proc. Verb.* XC, pp. 22-26.
- DEVOLD, F., 1952. A Contribution to the Study of the Migrations of the Atlantio-Scandian Herring. *Cons. Int. Explor. Mer., Rapp. et Proc. Verb.* 131, pp. 103-107.
- FULTON, T. W., 1897. The currents of the North Sea and their relation to fisheries. 15th Ann. Rep. Fishery Board Scotland 1896, Part. III, Sci. Invest., pp. 334-395.
- GRAHAM, M., 1935. Modern Theory of Exploiting a Fishery, and Application to North Sea Trawling. *Journ. Cons. Int. Explor. Mer*, X, No. 2, pp. 264-74.
1948. Rational fishing of the cod of the North Sea. The Buckland Lectures for 1939, London.
- HELLAND-HANSEN, B. and NANSEN, F., 1909. The Norwegian Sea. Its Physical Oceanography based upon the Norwegian Researches, 1900-1904. Rep. Norwegian Fishery and Mar. Invest. Vol. II, Part. I, No. 2.
- HENSEN, V., 1911. *Das Leben im Ozean nach Zahlungen seiner Bewohner*. *Ergebn. der Plankton-Exped. der Humboldt-Stiftung*, Bd. V., O., Kiel und Leipzig.
- HENSEN, V., and APSTEIN, C., 1897. *Die Nordsee Expedition 1895 des Deutschen Seefischerei-Vereins. Ueber die Eimenge der im Winter laichenden Fische*. *Wiss. Meeresunters.* Kiel und Helgoland, Bd. 2, Heft 2, pp. 1-97.
- HJORT, J., 1914. Fluctuations in the Great Fisheries of Northern Europe viewed in the light of Biological Research. *Cons. Int. Explor. Mer, Rapp. et Proc. Verb.* Vol. XX.
- HJORT, J., JAHN, G., and OTTESTAD, P., 1933. The optimum catch. *Hvalradets Skrifter*, Nr. 7, pp. 92-127.
- HODGSON, W. C., 1932. The forecasting of the East Anglian Herring Fishery. *Journ. Anim. Ecol.* Vol. I, No. 2, pp. 108-118.
- HOLT, E. W. L., 1893. North Sea Investigations: III. Remedial Measures. *Journ. Mar. Biol. Assoc. N.S. Vol. III*, No. 1, pp. 105-06.
- KNUDSEN, M., 1899. *Hydrography... The Danish Ingolf-Exped.* Vol. 1, No. 2, pp. 23-161. Copenhagen.
- LEE, A. J., 1952. The influence of Hydrography on the Bear Island Cod Fishery. *Cons. Int. Explor. Mer, et Proc. Verb.* 131, pp. 74-102.
- MOORE, S. A., MOORE, H. S., 1903. *The History and Law of Fisheries*. London.
- PETERSEN, C. G. J., 1894. On the Biology of our Flat-fishes and on the Decrease of our Flat-fish Fisheries. *Rep. Dan. Biol. Stat.* IV.
1921. On the stock of plaice in relation to the intensive fishing of the present times in the Belt Sea and other waters. *Rep. Danish Biol. Stat.* XXVII, 1920.
- PETTERSSON, O., 1905. On the probable occurrence in the Atlantic Current of variations periodical, and otherwise and their bearing on meteorological and biological phenomena, with an introduction. *Cons. Int. Explor. Mer, Rapp. et Proc. Verb.* Vol. 3, App. A.

- RUSSELL, E. S., 1931. *Some theoretical considerations on the "Overfishing" problem.* Journ. Cons. Int. Explor. Met VI, pp. 3-20.
1932. *Is the destruction of undersized fish by trawling prejudiced to the stock?* Cons. Int. Explor. Mer, Rapp. et Proc. Verb. LXXX, VIII.
- THOMPSON, H., 1930. *On the possibility of effecting and utilizing accurate estimates of haddock fluctuations.* Cons. Int. Explor. Mer, Rapp. et Proc. Verb. 68, pp. 27-53.
- THOMPSON, W. F. and BELL, F. H., 1934. *Biological Statistics of the Pacific Halibut Fishery (2) Effect of changes in intensity upon total yield and yield per unit of gear.* Rep. Internat. Fish. Comm. No. 8.
- INTERNATIONAL COUNCIL, 1928. *Rapport Jubilaire (1902-1906)* Cons. Int. Explor. Mer, Rapp. et Proc. Verb. 47.
1948. *The Effect of the war on the Stocks of Commercial Food Fishes.* Cons. Int. Explor. Mer, Rapp. et Proc. Verb. 122.
1952. *Rapport Jubilaire.* Cons. Int. Explor. Mer, Rapp. et Proc. Verb. 132, Copenhagen.
- H. M. STAT. OFF., *International Convention for the Regulation of the Meshes of Fishing Nets and the Size Limits of Fish.* London, March 23, 1937. Cmd. 5494. Miscellaneous No. 5. (1937).
- Final Act and Convention of the International Overfishing Conference London, 25th March 5th-April 1946.* Cmd. 6/91. Miscellaneous No. 7 (1916).

50 Years of Progress in Solving Fishery Problems

WILLIAM C. HERRINGTON

*The Special Assistant for Fisheries and Wildlife to the
Under Secretary of State, Washington, D. C.*

The subject under consideration is a broad one, for accomplishments in the field of fishery biology are many. They may be found in the way of general additions to knowledge, contributions to the philosophical or practical solution of problems, benefits to the individual, and doubtless many others. However, this discussion will be confined to accomplishments in solving, or contributing to the solution of problems of fishery conservation and productivity, particularly in the field of commercial fisheries. The term "accomplishments" will be considered in its broadest sense, for fishery biology has contributed to many non-biological accomplishments.

The State of Fishery Knowledge 50 Years Ago

One procedure for checking on accomplishments is to consider the state of knowledge in the field of fishery biology 50 years ago, as a starting point from which to measure progress. Any difference in the situation then and now can be considered as an accomplishment, whether good or bad.

The Proceedings of the Fourth International Fishery Congress held in Washington, D.C., in 1908 provide a good source of information on this subject. Assuming some lag between the development of ideas and the presentation of such ideas in print, it may be reasonable to conclude that the reports at this Fishery Congress in 1908 reflect the general situation in the field of fisheries some 50 years ago.

In discussing international regulations of fisheries on the high seas, Mr. Charles E. Fryer, Superintending Inspector of the Board of Agriculture and Fisheries, London, made the following statement:

"The Fisheries carried on in the high seas are to a large extent concerned with fish of whose habits we know very little. Notwithstanding all that has been done here in this great country — probably more than

in the rest of the world put together, we still find that we are exceedingly ignorant of the minutiae of the habits and of the habitat of the fish which constitute the great harvest of the sea. The more we know, the more I think we find we need to know, and there is an enormous field of research to be exploited before we can decide whether any protective measures should be adopted for the furtherance of the fisheries carried on in the high seas, more particularly with reference to those fish which are classed as pelagic rather than those which are more local in their habits. The first consideration, therefore, would be to decide upon a method of investigation. . . . We have found that we have made regulations in many cases — in most cases — without sufficient information; and then, having made regulations, we have had to set to work to a very much larger extent to find out whether they are justified by the facts before us."

In a formal report later made to the Congress, Mr. Fryer also stated:

"The further afield the fishermen of any State go, the more certainly will they be brought into closer relations with the fishermen of fresh nationalities, and the longer will be the list of States which find that they have interests in common — interests which will, sooner or later, call for combined action in the direction of international regulation of the fisheries on the high seas. Whether such regulations should aim at the protection of the fishermen — either in their lives, their property, or their morals — or at the protection of the fisheries against overfishing, must depend on circumstances. . . . It is far easier to prove that the lives or property of fishermen are in danger than it is to establish any connection between the fishing operations of the fishing fleets and the fluctuations in the yield of the fisheries, especially in the deep seas; and as a preliminary to any effective steps for the protection of the fisheries on the high seas by way of international regulations, it will be found necessary to provide for international agreement as to the nature and extent of the statistical records to be kept and as to the method and scope of research into those natural phenomena which affect the productiveness of such fisheries more extensively than the combined operations of all the fishing fleets."

In the same discussions, Mr. Charles Hughes Stevenson, of the United States Bureau of Fisheries, expressed the following opinions:

"So far as regards the demersal or bottom fishes — the cod, haddock, halibut, flatfish, etc. — our present knowledge of the remedial effects of fishery restriction is so slight as scarcely to furnish a satisfactory basis for even national legislation in territorial waters, much less for complicated international regulations."

Finally, Dr. David Starr Jordan, Commissioner of the International Fisheries Commission of Great Britain and the United States (covering fisheries of the Great Lakes and other boundary waters of the United States and Canada) commented as follows on the problems to be considered under this Commission:

"In nearly all cases the final key to the situation is found in artificial propagation — the development of the hatchery. This demands, however, men who are willing to study their business and to learn thoroughly the nature of the fishes concerned — the egg, the fry, and the adult. Artificial hatching is not a process. It is an art, and like all arts it must rest on science. How much of the money spent on hatcheries has been wholly wasted no one can tell, but the amount is considerable."

The above quotations give a glimpse of the state of fishery science and fishery knowledge in 1908, although some of them could easily be contemporary. In general they indicate some qualitative knowledge of the fish but an almost complete lack of quantitative knowledge of fish stocks. This is further illustrated by reference to other reports at the Congress. In the discussions on menhaden, Professor Goode was quoted to the effect that he estimated approximately a million million of millions of menhaden (10^{18}) were killed annually by natural enemies. W. F. Hathaway's paper, read at the same meeting, indicated that Dr. Hugh M. Smith and Professor Baird, both noted figures in fisheries, approved of this general estimate and the reasoning by which it was deduced. Some rough calculations can be made using Goode's estimate. At one pound each, 10^{18} menhaden weighing 70 pounds per cubic foot would occupy about 1.4×10^{16} cubic feet of space. This is roughly equal to the volume of 1,400,000 square miles of ocean with an average depth of 50 fathoms. The total area of the continental shelf inside the 100 fathom curve, probably averaging 50 fathoms or less in depth, from the Gulf of Maine to the southern tip of Florida, is much less than 100,000 square miles. Thus, it would take more than 14 times the total space available out to the edge of the continental shelf, to provide room for the menhaden packed solid, "estimated" by Professor Goode.

With this as a background a conclusion can now be risked that we have made considerable progress in the science of fishery biology during the past 50 years, but probably less than one might off-hand assume. In the course of this progress it is likely we have disproved more than we have proved, and we can still look with the greatest sympathy upon Mr. Fryer's comments on the complexities of the ocean.

Transitional stages

One might maintain that we have gone through certain transitional stages in reaching our present position. We have passed through a period which might be designated as the age of the "Philosopher's Stone" — a period during which it was frequently hoped and believed by many that man had discovered some one magic operation or regulation which would ensure the continued productivity of the stocks of fish. Judging by the quotation from Dr. Jordan, many believed in 1908 that artificial propagation was the answer to our dilemma. Then and later many believed that through some specific regulation, such as the widely advocated proposal that all fish should be protected until they had completed one spawning, the continued abundance of fish would be ensured. Some years after 1908 a considerable group convinced themselves that the newly discovered phenomenon of increased growth rate with decreased density of fish, would ensure the productivity of the fisheries. This latter philosophy was championed at one time by Professor Garstang, and in my notes it is listed as the "Fairy Godmother Concept." These and other beliefs from time to time have held an important place in the thinking of fishery conservationists, but now are generally discredited as magic cure-alls by the current group of professional thinkers and workers in this field, although relics of such beliefs may still persist in some quarters.

As a matter of fact none of these contentions is completely wrong. Artificial propagation, minimum age or size limits, and increased growth rate under intensive fishing, all play their part in the solution to the problem

of maximum sustained productivity of the fish stocks. It is the job of fishery biology to evaluate this part and see that each measure or characteristic is made use of in situations where it will contribute most to the solution—and contrariwise, see that it is not used where it is useless or worse. They are items in the fishery administrator's kit of tools which the fishery biologist must help him to understand and use properly. The more such tools the fishery biologist can master and add to the kit, the nearer will we be to the solution of our problem.

During the past 50 years it has become generally accepted among professional fishery workers that there is no single simple solution to our fish productivity problems. These problems are highly complex, require thorough study of their many aspects, and usually require use of complex management programs. In very few cases can we claim to have achieved even partial solutions.

Two approaches to the study of certain fishery problems

The approaches to the study of these fishery problems can perhaps be divided into two general types. The first might be called the synthetic approach. This holds that we should begin with a quantitative study of the basic nutrients, their seasonal variation and distribution, and build up from these to quantitative knowledge of the plankton and the dependent food chain, to reach an adequate understanding of the quantities of useful fish and the factors which control their productivity. The second approach might be called the analytical approach. This, in general, proposes that studies begin with the fish which are being utilized, with their abundance and productivity, and follow from there down or out, to determine and evaluate the principal factors which control their productivity.

Proponents of each of the two approaches have held forth in the past and continue at present. Let us quote again from Mr. Fryer at the International Fishery Congress, concerning the International Council for the Study of the Sea:

“That council started with a very large programme of research, involving many matters, which those who are interested in fisheries know are concerned with fishery development, and which influence the movements of fish, such as temperatures, currents, depths, salinity, and generally what is summed up in the word ‘oceanography’. But, while all these matters are necessarily involved in the great question of fishing and fisheries, they are not necessarily essential to the study of some of the more important problems that we have to deal with, and the International Council which has been established with regard to the North Sea is finding that it has to limit its programme and to take up some of the more pressing and urgent questions, rather than to deal with the study of fish and fisheries of the ocean at large.”

This experience of the Council is not unique. Continuing after the time of the Fishery Congress, many fishery workers held optimistic hopes that the basic productivity of the sea could be determined through development and application of quantitative methods for studying plankton, initiated by Henson and other workers some years earlier. However, by 1920 it began to be apparent that the complexities and magnitude of the sea were so great, and the errors of observation so considerable, that the precision of observation and extent of facilities were still far short of being adequate

to justify much hope that this synthetic approach could soon provide answers to the practical problems of the fisheries.

Since that time the science of fishery biology has developed, assisted in the development, or in some cases simply benefited, by new methods and tools which enable us to go far beyond the practical limits of 50 or even 25 years ago. The deficient statistical records, referred to by Mr. Fryer in 1908, have since been greatly improved and expanded so that for many of our fisheries we now have a fairly accurate record of the quantities of fish annually landed. In some fewer cases we have further information on the amount of fishing effort which has been expended in their capture. These two series of records together make it possible to obtain a measure of the availability of fish to the fishing gear, which reveals with more or less accuracy the changing density of the fish stocks. We have developed devices which provide us with accurate quantitative measures of various characteristics of the fishes' environment and it is possible to operate these rapidly, so that better and greatly increased quantities of data can be obtained by expenditure of the same time and effort. We have greatly improved and developed statistical procedures which make it possible to extract comprehensible information and conclusions from these tremendous bodies of statistical and other data and to test the significance of these conclusions. We also now have available efficient and complicated calculating machines with which to handle the masses of data which heretofore would require the services of such extensive manpower as to make the cost and time prohibitive.

In the field of planning we now have available more advanced hypotheses and theories (mathematical models if you will) concerning the dynamics of fish populations and their productivity, which make it possible to approach our problems in better organized and more effective ways.

Through various of these improved facilities we have advanced our knowledge somewhat with respect to one of the problems to which Mr. Fryer referred: that is, "the establishment of any connections between the fishing operations of the fishing fleets and the fluctuations in the yield of the fisheries."

Some accomplishments

Fishery biologists have demonstrated to the satisfaction of most scientists that there is a real and direct relation between fishing intensity and the sustained yield of some species, including salmon, halibut, haddock, North Sea trawl-caught fish, east China Sea trawl-caught fish, and whales. It has been shown that in some cases this results from capture of the fish before they attain their most productive size, in others through reduction in the spawning stock to levels which affect the production of young, while in others it develops simply from the reduction in the total abundance of marketable fish as a result of intensive fishing.

In some fewer cases it has been demonstrated, again to the satisfaction of most scientists, that through controlling the kind and quantity of fishing effort, a higher continuing yield of some species such as halibut and salmon can be obtained. In the case of stocks of whales off the east coast of Asia, the conservation management program of Japan—the only nation exploiting these stocks on a considerable scale—has resulted in their continued high productivity, in contrast to what has happened to whale stocks elsewhere

on the high seas. Other management programs recently have been undertaken through agreement on the use of large-meshed gear to protect small fish in the Gulf of Maine and the North Sea.

Progress in handling international problems

One of the earlier quotations from Mr. Fryer, among other things, referred as follows to the problem of international regulation of the fisheries on the high seas — "The further afield the fishermen of any State go, the more certainly will they be brought into closer relations with the fishermen of fresh nationalities, and the longer will be the list of States which find that they have interests in common — interests which will, sooner or later, call for combined action in the direction of international regulation of the fisheries on the high seas."

Prior to the 1908 Fishery Congress, various nations had tried from time to time to solve their joint fishery problems by conventions for the regulation of high seas fisheries. Some success was achieved in settling issues concerned with "rules of the road," conflicts in gear, and such operational problems. However, no particular success developed with respect to problems of fish productivity. Probably this resulted from lack of knowledge and techniques of fishery research and management as much as from anything, although the various complications deriving from international action must have played an important part.

Since that time, however, beginning in 1923, the United States, working with Canada and later with other countries, has embarked on a system of fishery research and conservation conventions which are proving brilliantly successful in restoring and safeguarding the productivity of common high-seas fishery resources. Progress has been made through careful step-by-step exploration of practical ways and means for developing and coordinating research, and devising suitable, effective, and practical conservation measures for promoting the sustained maximum productivity of the stocks of fish covered by the conventions. As one step proved itself and convinced an always skeptical fishing industry and public, which watched with a critical eye this increasing delegation of responsibility and authority to an international body, it was possible to move on to development and adoption of additional measures to handle more involved problems of these and other fisheries which have later been covered by fishery conventions. Thus by means of much study, discussion and negotiations, since the first halibut convention in 1923, we have developed and tested a considerable assortment of procedures for handling a variety of international fishery conservation problems.

The success of these conventions has been possible only because of the contributions of the science of fishery biology and some exceptional fishery biologists. The fishery commissions never have had funds or staff adequate to tackle all the direct and related problems of these fisheries — the synthetic approach. Their success, to a considerable extent, has resulted from the ability of their directors and staffs in identifying the most critical problems, getting the answers or a large measure of the answers to these problems, convincing the fishermen and public that these answers justified action, and then progressing onto the management steps in the complex of research and management.

Pacific Halibut Convention

The Halibut Convention between the United States and Canada, negotiated in 1923, was the first example of a successful attempt for international conservation regulation of a high-seas fishery. Several characteristics contributed to its success. First of all, the fishery concerned only two countries. It was confined largely to a single type of fishing operation. The fishery had expanded rapidly and the yields in individual areas had declined with alarming rapidity. However, success was furthered most of all by a realistic and effective research program which determined, then concentrated upon, the lines of research which revealed the relation between the fishery and the stocks of fish, and indicated the management measures which would be most productive. As first negotiated, this Convention provided for an international commission empowered to conduct research but not to regulate. The results of the research were so convincing that the Convention was renegotiated in 1930 to include terms which gave the Commission the authority to regulate the fishery. This Commission has its own research staff and makes use of an advisory committee including representatives from the halibut industry. The Convention provides for equal sharing of the expenses.

The Halibut Convention has been revised from time to time to keep it up to date and permit the most effective handling of its responsibilities. Following inauguration of the management program of the Commission, the decline in the halibut stocks was halted, and there has been a major increase in the productivity since then until at present the total annual production approaches that during the early years when the fishery was drawing heavily upon accumulated stocks.

Pacific Sockeye Salmon Convention

The United States and Canada ratified their second fishery convention in 1937, to cover the sockeye salmon of the Fraser River, which had been practically wiped out as a result of land slides and overfishing. This Convention provides for regulation only after research covering two cycles of the salmon run, or eight years. The costs of the Convention are divided equally between the two Governments, and the Commission is required to regulate the fishery in such a way that the catch is divided as nearly as possible in equal shares to the fishermen of the two countries. After eight years of investigation the Commission proceeded with regulation and the construction of fishways at Hell's Gate, which the Commission's investigations had clearly demonstrated were critical to the rebuilding of the salmon runs. The Commission's work is now showing practical results in the rapid increase in the runs of sockeye. Through the continued operations of this Commission it is confidently expected that the runs, worth many millions of dollars annually, will be restored and maintained at maximum productivity.

Inter-American Tropical Tuna Convention

Encouraged by the results of the Halibut and Salmon Commissions, the United States Government more recently has sought the solution of other international high seas fishery problems, using a similar approach. In 1949 we negotiated with Costa Rica the Inter-American Tropical Tuna Convention. This Convention provides for research on the yellowfin tuna, skipjack and the bait fish found in the waters off the Pacific Coast of the

Americas, and for recommending to the Contracting Parties any conservation measures found necessary. It adds two new features to our fishery conventions: One, the Convention is open-ended—that is, any of the nations concerned with these fisheries can adhere to the Convention at a later date with the consent of the countries then party to the Convention; and it provides that the costs of operation will be divided among the contracting parties in relation to the catch of the fishes covered by the Convention. It is hoped through this Convention to develop the cooperation of all of the coastal States off which tuna are found, in a program of research and, if necessary, regulation. Recently Panama has adhered to this Convention and is now a member.

Northwest Atlantic Fishery Convention

For the past two decades many people interested in New England's high seas fisheries have strongly advocated a fisheries convention among the nations fishing the Northwest Atlantic. This finally led to the negotiations in 1949 of the Northwest Atlantic Fisheries Convention, which Convention includes all ten countries from the two sides of the Atlantic whose vessels fish in the area. Several new features are included in the convention to handle the special problems arising with so many countries fishing in variable degrees in the different parts of the Northwest Atlantic area. The Convention provides for the setting up of separate "panels" for sub-areas, each panel to include only those nations fishing in the sub-area covered. It is possible by this means to bring the many separate problems involving the different groups of countries in each sub-area under one over-all convention. This avoids the necessity of a multiplicity of separate agreements. The operations of the Commission are financed on the basis of \$500 annually from each contracting party, with the remaining costs divided among the parties in proportion to the number of panels on which they are members. In the field of research it provides that the Commission set up under this convention shall arrange for the cooperative study of the fisheries problems of the area through preparation of an over-all research program, and coordinating the work of the several countries party to the Convention, rather than by operating its own research staff, as do the halibut, salmon and tuna commissions.

North Pacific Fisheries Commission

The most recent fishery agreement to which the United States is a party is the North Pacific Fisheries Convention, negotiated between the United States, Canada and Japan, to resolve their serious and persistent fisheries problems in the North Pacific. In this convention several important procedures and concepts were introduced to provide for suitable handling of a number of new problems not covered by previous agreements. Probably the foremost is the concept of abstention. This concept sets forth the principle that when a stock of fish is being completely utilized and regulated, on the basis of extensive scientific research, to provide for the maximum sustained productivity of this stock, the entry into this fishery of the fishermen of other countries not previously participating in the fishery and in the related research and management program, could not increase the over-all sustained production but would serve principally to discourage such research and management programs as had preserved the productivity of the fishery.

Any effective program of research and regulation restricting the operations of a nation's fishermen, to promote maximum productivity, would be virtually impossible to maintain if the gains in productivity thus produced could be harvested by fishermen of other countries which had not participated in the research and regulation nor submitted to the restraints. It therefore follows that under such conditions non-participating countries should agree to abstain. This principle is observed in the Convention. The Convention also deals with stocks of fish rather than areas as management units, a sound biological concept which follows our actual practice in the halibut and salmon conventions. It also provides for the setting up of a committee to decide on a possible point of dispute concerning the line provisionally agreed upon for separating stocks of salmon of North American and Asian origin.

The Convention provides for the coordination of the research of the several countries, with the Commission itself carrying on research only where it is not feasible to use established research agencies. It provides for either trilateral or bilateral action on research and necessary conservation measures, with participation in decisions and recommendations limited to the Commissioners from the countries engaged in substantial exploitation of the stock concerned. Joint expenses are to be paid in proportions recommended by the Commission and approved by the Governments. This provides for the division of costs in relation to the fields of activity of the Commission and the countries chiefly benefited by its activities. These provisions give the Convention a flexibility which makes possible the handling of any fishery conservation problem in the area, whether it involves any two or all three countries.

There are other international fishery problems with which the United States is much concerned. They are being studied to determine whether ways and means can be developed for their handling. I am optimistic that with the continued progress of the science of fishery biology, information and procedures can be developed to a point where these problems can be handled with a success equal to that which has characterized our past activities in this field.

Conclusion

What light does this brief review of the past 50 years throw on the future? First of all, it indicates that our progress in handling problems related to maximizing the productivity of stocks of fish has been handicapped chiefly by lack of information and by mis-information. To correct this situation is the primary task of fishery biology. How can this best be done? One thing we can do is stress the development of more precise data. Unless we can attain a much higher degree of precision in our evaluation of the essential parameters of fish stocks, our conclusions must continue to be guesses. Another productive move would be to concentrate further attention on determining and evaluating the controllable factors affecting fish populations. An understanding of other uncontrollable factors is very useful in predicting changes in the availability of fish stocks and sometimes in enabling us to avoid fruitless regulations, but in the final analysis we will not be able to control these factors to produce the results in which we are most interested.

Of the controllable factors, probably the most important is the intensity

of fishing. Present work shows that, at least in many species, this intensity affects the abundance level of fish stocks. We know, as a biological truism, that in general as a stock of fish increases in numbers natural mortality increases until the number of fish is brought into uneasy equilibrium with the environment. The actual level may vary from year to year but to the best of our knowledge it maintains some long-time over-all average (if we can ignore the climatic cycles stretching over hundreds or thousands of years.) Such a balance is developed through increasing intra-specific competition for food and space, increased cannibalism and predation, or other factors related to increasing density of population. We know also that as a population is reduced in abundance a level eventually must be reached where the production of eggs and young is insufficient to make full use of the environment. At some level or levels between these extremes, the optimum conditions must exist with respect to adequacy of spawning and minimum mortality rates. It may be that the level required for adequate spawning is so low as to enable us to disregard it as a practical matter. It may also be that significantly increased mortality rates develop at abundance levels sufficiently high that we may disregard them in a reasonably intensive fishery. However, results of some investigations such as those on haddock, indicate that these factors can be of considerable importance, at least at some of the abundance levels actually observed. Where this is so, an understanding and evaluation of these factors would provide some of the most promising tools for the fishery investigator and administrator.

DISCUSSION

BIOLOGICAL SESSION

Discussion Leader: PAUL GALTSOFF

Discussion Panel: J. L. McHUGH, THOMAS H. LANGLOIS, HARDEN TAYLOR

Galtsoff:

You have heard the papers given this morning by Dr. Hile, Dr. Graham, Mr. Herrington and Dr. Schaefer. A certain emphasis has been placed on the use of mathematical analysis to reveal the mysteries of the population fluctuations in the sea. I would like the audience to inject their ideas in relation to these annual fluctuations and the social, political and economic disturbances caused by changes in the ecological situation in the fisheries. The first paper we will have in our discussion on will be Dr. Hile's paper and the problems of the fisheries in the Great Lakes.

Langlois:

I am in substantial agreement with Dr. Hile's paper. I do think that several points should be carried further to take in the fluctuations in the fisheries. The variability found here is a function of environment and is apart from fishing activity.

Lake Erie is a pool in the Great Lakes system, besides being considered a separate entity. All of the lakes except Lake Erie are below sea level. Lake Erie

is also shallower, generally warmer, and quite different from the rest.—

(Charts were shown and the physical characteristics of the lake pointed out).

Regardless of the fishing effort in Lake Erie the fish populations fluctuate. The abundance of the Coregonids in particular is dependent upon conditions being favorable to the food cycle.

Certain conditions favor survival. When these conditions are good the number of pounds of fish landed is high. In 1945 the cisco catch was high and as the success of this year class dropped off and conditions became poor in 1947 the stock disappeared.

The western end of Lake Erie is the key area. If there is a good fish survival year the productivity is high and fish can be landed cheaply. An economic problem is involved then.

The various environments are of the most importance in the welfare of the stock. Some economic gain may be realized by a change in the fishing effort but this would not make conditions better for the fish.

H. Taylor

I, too, am in agreement with Dr. Hile. All of the papers give us reason to be proud of fishery biology as a science. My retrospective view of them, however, is that all of the papers leave out the economics of the fisheries. I think of economics as everything being related. This can be likened to the fish net with its many knots. Cutting out or displacing any of the knots has an effect upon every other part of the net.

With each fishery at its maximum yield we would have a bad condition, for prices would be low. In the Maine lobster fishery the catch today is only 40 per cent of the catch in 1890, but the price is six times greater and the purchasing power of the fisherman has been increased three times.

Nature seems to follow the Sherman Anti-Trust Laws in limiting production. In the early years the main inland areas did not have any fish except the salt cod. As the population grew and we had better icing and shipping facilities Cape Cod fish were shipped west to St. Louis and Kansas City. At first they were getting 100 per cent Cape Cod whiting. Later on many other species which resembled the fresh water panfish, to which these people were accustomed, were shipped inland. This new trend affected the economics of the fisheries. There was a change in prices, demand and supply. The fisherman was also called upon to put forth a more intensive effort in fishing for new species.

These changes in economic conditions have affected

prices and production and can result in the fisherman getting more money for less fish.

McHugh:

The fisheries of the Great Lakes are complex, with the gear taking more than one species. We have the same situation in Chesapeake Bay. There are three or four major types of gear, pound nets, haul seines, gill nets and trawls, which all catch the same types of fish. If we were in a position to know the biological condition of a fishery the management of the fishery would still be difficult. How could we tell the fisherman what the limits were? We have pound netters and off-shore trawlers operating on the same species.

Q. Allee:

I would like to know about the smelt and lamprey problem in the lakes.

A. Hile:

The smelt problem is unsolved. We do not know if it is a blessing or a curse but right now the fishermen are benefitting. With a rise in smelts the other species decrease. Mortality of smelts is followed by a rise in other species.

The lamprey is the cause of the collapse of the lake fishery at Lake Michigan, especially the lake trout. The main food of the lake trout was the chub and bloater. The subsequent relief of pressure by the lake trout on the chub and bloaters has resulted in the increase in these latter species which now fill the lake and make fishing difficult.

Galtsoff:

We can proceed to a discussion of the papers of Dr. Graham and Mr. Herrington. Since these are similar I think we might discuss them together.

Q. H. Taylor:

I noticed references to Goode's paper in Mr. Herrington's discussion. I have found that Goode got himself all tangled up and there are many mistakes in his calculations and estimates. I mean no discredit to Goode who, if he were alive today would probably have corrected these mistakes.

Since 1908 the jurisdiction of the government has been extended and treaties have been entered into with several foreign countries. Even though the production of Costa Rica is very low it is the subject of a treaty. In a bulletin put out by the State Department in 1949 they state that it is the policy of the U. S. to provide for the possibility of each fishery in the world in order to obtain a maximum yield. This is hard to understand. The fishery biologists leave too much out. What would the effects be if the croakers in North Carolina were more plentiful. The maximum sustained yield theory does not go along with the theory in that increased catch reduces price and the fishermen do not benefit.

The population centers change and conditions change. From 1900 to 1940 there has been a reduction

in the number of fishermen but the amount of production is the same.

I question the use of the word "profit" as it is used in this paper. The North Sea is our heaviest fished area. In England when the markets were glutted with herring the fishery remained the same. When the fish were depleted, the costs rose and other fish were competing with the herring. This competition sent the fishermen to Iceland where new fishing grounds were discovered. The operation of the economic laws brought this discovery about. The fisherman has found out that the fish are not where the people are and that he must go out to get them.

A. Pritchard: I can assure you that we, in Canada, do consider the social and economic problems of the fishery as well as the biological. Our deputy minister is also an economist. Under our constitution the federal government has jurisdiction over the fisheries. By agreement, the provinces, under the federal act, take over these duties. I do believe, however, that the dollar will control fish populations.

Q. F. G. W. Smith: The area of the Caribbean needs protein food. In the future we look for an increase in population in this area and therefore an increase in the need of fish as a source of protein. Certainly biology is worth while in many instances. One might cite the transplantation of the striped bass and the shad or the establishment of the French oyster as classical examples of instances where biology has been beneficial. A further analysis of the economics might reduce their value. Yet, I challenge the fishery biologists to show where population dynamics and control have been beneficial.

A. McHugh: One definite accomplishment we have made is to knock the hatcheries idea on the head. This will save much money in the future.

A. Pritchard: The salmon hatcheries in British Columbia were stressing the wrong phase of the life history, and did not accomplish much.

Q. Schmidt: I would like to ask Dr. Taylor one question. If he is so opposed to biologists why is he one of the prime movers in the development of fishery biology at Morehead City?

A. H. Taylor: The Institute at Morehead City is not interested purely in fishery biology. We are also interested in economics and marketing.

Q. F. G. W. Smith: I am hopeful that by looking over the accomplishments of the past years the fishery biologist can approach his problem with a new attitude. In many instances the fishery biologist has operated by necessity rather than by intention. His work is only one of the means of solving the overall problem of extending the fish bank,

but it is an essential one. In almost every case the public is not interested in why certain things happen. We need people who can direct the activities of subordinate groups in an overall way, taking into account the economic as well as the biological factors to extend and increase our supplies. Dudley Wiles did just this thing in Barbados, where there was a small fishery for flying fish, valued at \$780,000 a year. They were using sailing vessels and scoop nets, which Wiles persuaded them to abandon in favor of small gill nets. The result was an increase in the value to \$1,000,000 per year. This increase then brought about a problem of glut and a marketing problem. Further problems of freezing, transportation and economics were also confronted, but are being solved.

I think the fishery biologist should work on his problems with all these aspects in mind with the ultimate object being that he should benefit society.

A. Schaefer:

(Schaefer explains his graphs further)

The biologists produce the work necessary to make these graphs and the picture they represent. There are four points of possible maxima in various terms of fish, or money. Dr. Taylor can choose his own maximum. It is not the job of fishery biologist to decide what to do after he has presented his information. It is also not the job of the fishery biologist to place restrictions on the fishery in all cases.

Q. H. Taylor:

What do you want people to do?

A. Schaefer:

That is not our problem.

Q. Pritchard:

I am on Schaefer's side as far as regulations are concerned. Nine hundred and ninety-nine out of one thousand of our regulations are no good. However, don't blame them on the biologists. We like to lift a regulation as well as put one where necessary. It is the decision of the people which prevails after the evidence has been presented.

A. Idyll:

It is a dangerous generalization to say that the work of the fishery biologist is always to restrict the fishery. In Florida we have suggested lifting regulations where our investigations have shown such restrictions are not warranted. We have suggested the lifting of the closed season on mullet; secondly we have lifted the ban on night fishing for shrimp. Our philosophy is to regulate the fisheries for the fishermen, not the fish.

A. Carlander:

In the early days regulations were not proposed by the biologists. In fact the first research by the biologist Thomas Huxley was to abandon regulations. Our aims are a maximum sustained yield and a profit to the fisherman. In agriculture we have research and production problems which are kept apart with the research being paid for by a lower cost production.

There may be times when we need the fishery biologist's knowledge, but this is apart from production. In any event we need a greater amount of protein production. I would like to take this opportunity to pat the fishery biologist on the back. It was through the biologist that we first found out that snappers could be found in deeper waters of the Gulf. This led to the development of electric reels and an increased production. Even today the snapper fishery has a chance for expansion with a need for better marketing facilities.

Another instance of the value of the fishery biologist's work is where they point out possible new areas to be exploited. Several years ago we were told by Luis Rivas that there were quantities of sardines in the Gulf which could be commercially exploited. On a recent cruise on the Oregon we sighted several of such schools which indicated the sardines were there in large enough quantities to be commercially exploited.

I have two questions to ask Dr. Schaefer. Does he take into consideration such an innovation to a fishery as the use of the depth finder or any new gear in his evaluation of his unit of effort? Also, when three boats fish together and get a higher unit of effort than when the fish single, does he weigh these factors?

A. Schaefer:

Yes, we do weigh these factors. There are different devices employed such as the size categories for boats and the use of link relatives in weighing the catch per boat. With cooperative fishing the problem is more complicated. Evaluation becomes more difficult but not impossible.

Q. Schmidt:

The work of the fishery biologist was found necessary as a result of the politician's need for data necessary to legislation. This data was needed when state pressure was put on to find out if the existing laws were any good. Our aims are to increase the income of the fisherman and make more protein food available to the people. As far as the economic laws of supply and demand are concerned it is the job of the commercial fish companies to educate the people and create a demand for seafood. I have a question for Dr. Taylor. How do you justify fishery investigations at Morehead City?

A. H. Taylor:

(No comment.)

A. Galtsoff:

The fishery biologist has his roots in the past and yet he must look to the future: he must recognize the activities of the past which will help in guiding his future actions. It was the necessity for an understanding of the fishery problems which was the forerunner of a desire for knowledge of the fisheries and the sciences of oceanography and marine biology. We

must give the fisheries credit for stimulating this oceanic research.

In one instance biologists were working on the pearl oyster problem at Ceylon years ago. There was no accomplishment but a wealth of information was learned about the biology of the sea. These volumes of academic and general knowledge were put into the records and can be used for 200 years. If you ask me if I think this work was wasted, I believe not. I think it was worth while.

Q. McHugh:

We have been considering using such methods as Dr. Schaefer in working on our oysters. In oysters the essential data such as growth rate, recruitment and natural mortality are easier to measure and work with than in another fishery. I believe our data show that the fisherman would be better off if he took up the oysters after 18 months rather than 3 years.

A. Schaefer:

The problem of harvesting of oysters is less trouble than in a more dynamic fishery such as the tuna. You can multiply your survival rate by your growth rate at any time to get your maximum yield.

The causes of fluctuations are important. There is always the relationship of fishing mortality and natural mortality. Some ecologists say that the natural fluctuations are so large that fishing mortality is negligible.

Our attempts have been to predict the situation in order to get the greatest yield. Even if we know only 50 per cent of the required information I think we should use the 50 per cent that we do know until we learn the rest.

Galtsoff:

The tool of statistical knowledge is a valuable one, but it is not a substitute for a knowledge of the biology, physiology and behavior of the species. In our next meeting I hope we hear more of the behavior of the species and am looking forward to advances being made in this area.

FRIDAY—NOVEMBER 20

Chairman — CHARLES E. JACKSON, General Manager,
National Fisheries Institute, Washington, D. C.

The Discovery of a New Shrimp Bank at Golfo de Batabanó, Cuba

ISABEL PEREZ-FARFANTE

Fisheries Research Center, Havana

With the opening of the Fisheries Research Center on March 9, 1952, at Playa Habana, Cuba, the writer was asked to make a taxonomic study of the commercial shrimp of Cuba, a task which had not been carried out until then. The first objective was to gather data and study material from different parts of Cuba.

The commercial shrimp fishery in Cuba catches three species of the genus *Penaeus*: *P. schmitti*, *P. duorarum* and *P. aztecus*, the two first ones being those that constitute the bulk of production. Two other species are also exploited, *Trachypeneus similis* and *Sicyonia typica*. The results of this research were published in the *Memorias de la Sociedad Cubana de Historia Natural Felipe Poey*, Vol. 21, January, 1953, under the title, "The Commercial Shrimps of Cuba."

In periodical visits to different fisheries centers of Cuba, data were gathered on the ecology of different zones. This resulted in the conclusion that not only were two of the Cuban species of commercial shrimp the same as those exploited in the Gulf of Mexico, but also that certain conditions of environment, principally the nature of the bottom, were similar to those of the zones of the Gulf where the large shrimp banks are found. This led to the conviction that the seas of Cuba's insular shelf also had shrimp banks, and prompted a series of explorations. Until this time shrimp fishing in Cuba was limited to the bays and the shallow coastal waters, the cast net being generally used. The exploratory program envisaged the need of dragging, using the methods which experience in other areas had shown to be the most suitable.

The vessel used in the exploration was the yacht, "Aida", owned by Mr. Torwald Sanchez. She is 50 feet long with a beam of 11 feet and a draught of six feet, driven by a 130 horse power motor and with a speed of 6.5 miles an hour. The "Aida" was equipped with a Bendix Marine Supersonic Depth Recorder. The shrimp net was 36 feet long with a mouth of twelve feet.

Exploration began on April 19, 1953. By the 14th of June 200 hauls had been made, averaging half an hour each. These explorations were carried out in the Gulf of Batabanó. Most of the fishing was conducted within a triangle formed by lines joining a point west of the Isle of Pines, off Sigüanea Bay, the mouth of the Hatiguanico River and the Batabanó anchorage. This is an area of some one thousand square kilometers (386 square miles). Most of the fishing was done between seven in the afternoon and seven in the morning. From the start the pink shrimp, *P. duorarum*, was caught in greater or less quantities. In one area, off the coast of Batabanó, 70 per cent of the

pink shrimp netted measured between 14 and 17 centimeters ($5\frac{1}{2}$ to $6\frac{3}{4}$ inches). A smaller species, *Sicyonia typica*, of approximately 10 centimeters (four inches) in length were ten times more numerous than the pink shrimp. In none of the hauls were specimens of *P. duorarum* of very small size.

The conditions of the environment in the Batabanó-Hatiguanico area may be summarized as follows. The *bottom* is muddy and rather consolidated, with a certain amount of mollusk shell, but free from vegetation. *Depths* of between 2.5 and 3.5 fathoms are common in this zone. An extraordinary amount of small crustaceans, mostly copepods, and of diatoms composed the *plankton*. This source of food has made the Gulf of Batabanó one of the richest in Cuba for sponges, lobsters, mangrove snapper, and other marine life. It was to be expected that shrimp should be abundant there.

The shrimp caught live in an animal community composed mostly of bivalves of the genus *Pecten*, the Gastropod *Bulla occidentalis*, squid *Doryteuthis*, sea urchins *Lytechinus variegatus*, mantis (*Squilla empusa*) and fish. The latter include mojarra (*Oligoplites saurus*) and (*Opisthonema oglinum*), "shad" or silver sides (*Eucinostomus pseudogula*), and peacock flounder (*Platophrys lunatus*), among others. All the species mentioned appeared consistently in the hauls.

Based on the results of these experiments, Mr. Thorwald Sanchez bought a typical American shrimper, completely equipped. This boat, named the "Ulda Velma", catches about 500 pounds of pink shrimp (*P. duorarum*) each night. The Cuban fishermen soon familiarized themselves with the new method of fishing, and it can now be said that they have mastered commercial fishing for shrimp. Shrimp had not previously been fished for in the Gulf of Batabanó, but since the arrival of the "Ulda Velma" a fortnight does not elapse without a new boat being equipped for this fishery. At this writing there are 11 shrimp boats working in this area and others are being made ready to enter this "pink gold" race. An average of seven to eight thousand pounds of shrimp of good size enter Cuban markets each morning, as a result of scientific contribution which was looked on at first with much skepticism. But enthusiasm has spread. Many fishermen are now preparing to carry on explorations on their own account, and there is already talk of new and richer fields. In midst of the satisfaction produced by success there is one concern, that in the enthusiasm the exploiting of this new fishery conservation may be ignored.

Migrations of the Common Shrimp (*Penaeus setiferus*) Along the South Atlantic and Northern Gulf Coasts of the U. S.

Abstract

WILLIAM W. ANDERSON

Chief, South Atlantic Fishery Investigations U. S. Fish and Wildlife Service

A description was given of the methods employed in catching, tagging and recovery of shrimp marked and released in a study of migration patterns. General migration patterns during the various seasons of the year were illustrated and discussed for the South Atlantic Coast from North Carolina to Florida. A general movement of larger shrimp from the northern and

central portions of the fishery to the southern portion of the fishery during the fall and early winter, and a northward movement from the southern portion of the fishery during the late winter and early spring was described. Migrations of shrimp in the northern Gulf of Mexico were discussed by sections: east of Mississippi River, in Louisiana west of the Mississippi River, and the lower Texas Coast. This presentation was in general terms; details will be presented in a paper to be published shortly and entitled "Growth, Migrations, Spawning and Size Distribution of the Shrimp, *Penaeus setiferus* (Linn.)," by Milton J. Lindner and William W. Anderson.

Evaluation of Five Pound Packages of Glazed and Unglazed Shrimp

MARIAN KLEIN, L. E. SIMERL*, and ERNEST ADAMS

Marathon Corporation, Menasha, Wisconsin

Because of the rapid growth of the shrimp industry during the last few years the need for additional information on the packaging requirements of frozen shrimp was found necessary. An investigation of the correct packaging conditions for several types of shrimp was started in December, 1951, by a review of the published literature and by discussions with several experts in the field. It was determined that the bulk of all frozen shrimp is sold as headless raw shrimp, which are packed in five pound packages and glazed with water. The glaze in this size package amounts to twelve to twenty ounces of water per package and serves to protect the shrimp during subsequent storage at 0°F. There has been considerable production of small "consumer" size packages of headless raw shrimp packaged without glazing, using a printed overwrap, and some five pound packages have also been made with overwrap. The experience of these packers and investigators has been that protection from the overwrap was apparently sufficient, and that there were no adverse effects on the quality of the shrimp (Anon. 1950; Fieger, 1950; Fieger, Green, Lewis, Holmes — DuBois, 1950; Divers, 1953). As a result of the recommendations of several authorities on shrimp processing and marketing the present tests were outlined, incorporating all of the suggestions which were obtained.

Shrimp are almost the only packaged frozen food now being glazed. Other frozen foods, including fish fillets, poultry, meat and vegetables, can be held for periods of at least one year when packaged without a glaze, but with a suitable water vapor barrier, such as an overwrap (Anon. 1951). Extensive packaging tests in this laboratory on all of these foods have shown that adequate protection is provided by a suitably waxed carton with a special overwrap which features a hard wax coating, designed for use at the low temperatures encountered in storage of frozen foods.

The glazing operation involves extra costs and problems, including the following:

1. Sharp freezing prior to glazing sometimes causes undesirable desiccation.
2. Shrimp packages must be opened after the initial freezing period and passed through the glazing line, involving extra labor.

* Present address: Olin Industries, Research and Development Department, Cellophane Division, New Haven, Connecticut.

3. Additional refrigeration capacity and 35°F. glazing water are required.
4. The ice glaze increases the package weight 15 to 20 per cent, with simultaneous increase in storage and shipping charges.
5. Undesirable effects are encountered, such as water leakage on inverting cartons, individual packages freezing together, water damage to corrugated shipping containers, and prolonged defrosting periods.

In view of these many disadvantages, it appeared desirable to eliminate the glazing operation. Therefore, a test program was initiated to determine whether unglazed shrimp could be held satisfactorily for long term storage at 0°F., when protection was provided by a heavy waxed carton with a suitable outer overwrap.

Texas brown shrimp (*Penaeus aztecus*) averaging 31 to 35 to the pound, were used in the experiments. These had been four days old in ice storage on a fishing boat. They were landed at the Pan Am Frozen Foods plant, Brownsville, Texas. Thirty packages were frozen; one lot was glazed a day later and the shipment was sent in dry ice to the Marathon Corporation Laboratories at Menasha, Wisconsin.

A duplicate test was set up at New Orleans, with white shrimp (*P. setiferus*), averaging 31 to 42 to the pound. These had been six days on ice when packed. The packages were handled under commercial conditions at both plants, with the exception that the top shrimp were arranged in a "layer pack", for better observation of desiccation and for photographs. A net drained weight of five pounds three ounces was used. The glaze on the brown shrimp averaged 18.2 ounces, and on the white shrimp 23.2 ounces.

The packages made up at both Brownsville and New Orleans had the following variations in glazing and wrapping:

A. Glazed Shrimp

1. Marathon high gloss wax, solid bleached carton with glued construction.
 - a) No overwrap
 - b) Moistureproof cellophane overwrap
 - c) "Tyton" waxed paper overwrap (thirty pound opaque paper waxed to 44 pounds with a special blend of waxes).
2. Present commercial carton fabricated of high gloss waxed board with stapled construction.
 - a) No overwrap

B. Unglazed Shrimp

1. Marathon high gloss waxed, solid bleached carton with glued construction.
 - a) No overwrap
 - b) Moistureproof cellophane overwrap
 - c) "Tyton" waxed paper overwrap

All cartons were one piece telescope style.

Package construction A-1-b and A-1-c above, in which shrimp were glazed and then overwrapped, are probably not commercially practical, but were included to indicate the degree of protection possible by both glazing and overwrapping, and to provide a standard of quality of shrimp against which other packages could be measured. Another package, B-1-a, in which the shrimp were not glazed and not overwrapped, is also not a commercial pack-

age because of its poor keeping qualities, but it was included to determine the extent of quality degradation which might occur with very poor packaging.

Upon arrival at the laboratory the master shipping containers were weighed, the individual packages were removed and examined, and damaged overwraps were replaced. The latter was necessary only in the case of the cellophane overwraps, as these were the only ones which arrived in a damaged condition. All packages were then transferred to storage at 0°F. ($\pm 1^\circ\text{F.}$) after removal of surface ice from the outside of the packages. The freezer used was a Wilson 8' x 12' commercial unit, with refrigeration provided by a Bush blower using Freon 12, at a design temperature of -10°F. Daily temperature records indicated that the temperature of the air from the blower was $0^\circ\text{F.} \pm 1^\circ\text{F.}$ (the same temperature as that in the entire room). The refrigerator coils were automatically defrosted once a day for thirty minutes, with a maximum air temperature in the room of approximately 5°F. The packages were arranged on racks out of the direct air blast, with free air circulation on all sides of each package.

After three days holding period at zero, four packages for each type shrimp and package construction were weighed to 0.1 gram to determine the initial package weight. All weighings were made inside the zero room. One set of packages was then reweighed and removed from test after three, six, nine, and twelve months storage. After determining the package weight loss, the cartons were opened, and the shrimp were examined visually for amount and location of the desiccation.

The five pound packages of shrimp, after observation of desiccation, were defrosted as rapidly as possible under running tap water at about 50°F. The surface shrimp, which suffered the most extreme damage according to visual observation, were isolated for the taste tests. These shrimp were peeled, veined and washed. The shrimp for taste tests were cooked under controlled conditions. One pound of cleaned shrimp was placed in one gallon of boiling water. When the water came to the second boil, the shrimp were removed from the water, drained, and chilled in cold water. The total time in hot or boiling water was about three minutes. The boiled shrimp, identified only by code number, were tasted by a trained panel of five persons. Observations of color, taste, texture, and off-flavor were recorded.

The taste panel consisted of a group of typical mid-westerners who were not particularly familiar with shrimp at the start of the test. They were familiar with panel testing of many other foods, particularly frozen meats, poultry, and fish. The taste panel was trained during the initial period of storage (zero time in months) using shrimp from extra five pound test packages. The cooking procedure was decided upon only after a series of trial cooks were made in which the ratio of shrimp to water, salt in water, and cooking time were varied. The final procedure, without salt, was believed to give fairly reproducible results, without interference to shrimp taste or texture.

The condition of the master shipping containers and individual cartons upon arrival at the laboratory was as follows:

1. The ten glazed packages within the master carton were frozen together as a result of leakage of water from inversion of the cartons after glazing. These cartons had to be forced apart prior to testing.
2. All of the glazed shrimp packages had a heavy layer of ice on the outer surface of the carton. This was removed before the storage tests.

3. The cellophane overwraps were generally severely damaged in shipment, and many had to be replaced prior to testing. The Tyton overwrapped packages arrived intact.
4. The master shippers, each containing ten five pound shrimp packages, were weighed upon arrival to determine the difference in the weight of shippers with unglazed and glazed shrimp. Two cartons of Louisiana shrimp with a glaze weighed 70 pounds 15 ounces and 71 pounds 5 ounces, while a carton of unglazed shrimp weighed 56 pounds 5 ounces.

The weight loss of the various types of packages after storage at 0°F. for three, six, nine and twelve months is shown in Table 1.

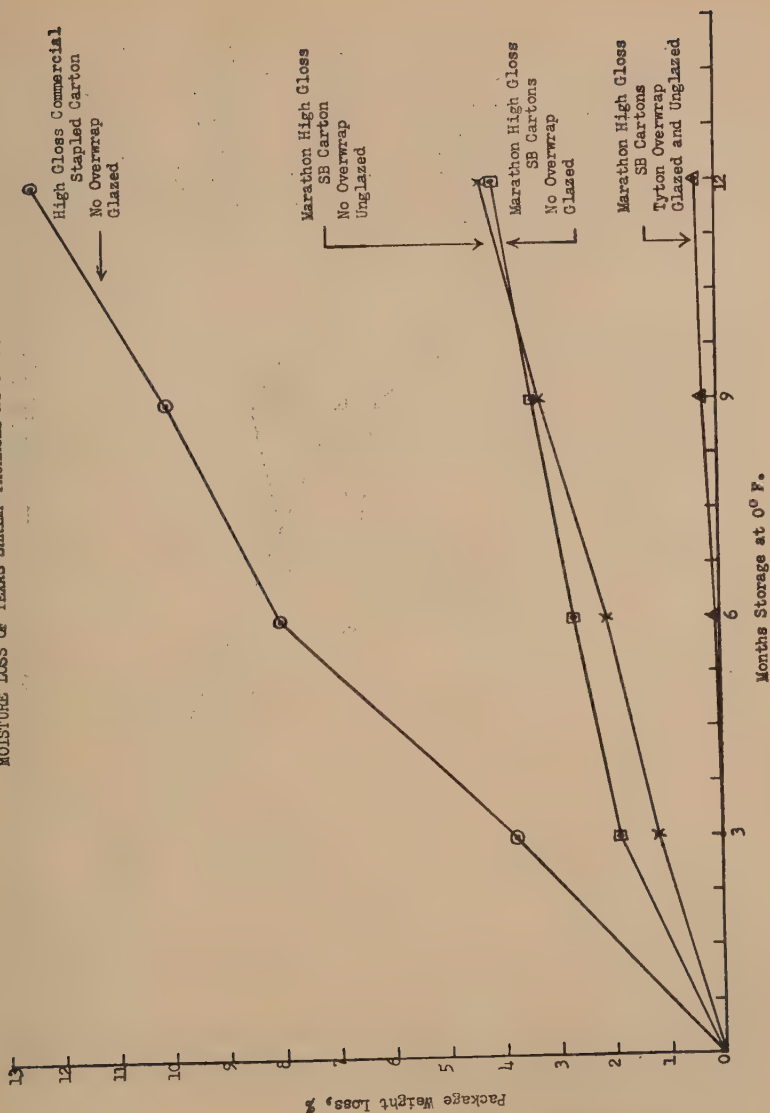
Table 1

Weight Loss of Five Pound Shrimp Packages After Storage at 0°F.

Type of Pack	Packing Materials	Texas Shrimp			
		3 Mo.	6 Mo.	9 Mo.	12 Mo.
Glazed	1a) Marathon High Gloss SB Carton No Overwrap.	1.9%	2.7%	3.4%	4.1%
	1b) Marathon High Gloss SB Carton Cellophane Overwrap.	0.1	0.1	0.2	0.1
	1c) Marathon High Gloss SB Carton Tyton Overwrap.	0.0	0.1	0.1	0.3
	2a) Commercial Stapled High Gloss Carton No Overwrap.	3.8	8.0	10.0	12.4
Unglazed	1a) Marathon High Gloss SB Carton No Overwrap.	1.2	2.1	3.3	4.3
	1b) Marathon High Gloss SB Carton Cellophane Overwrap.	0.2	0.2	0.2	0.2
	1c) Marathon High Gloss SB Carton Tyton Overwrap.	0.0	0.1	0.3	0.4
Type of Pack	Packing Materials	Louisiana Shrimp			
		3 Mo.	6 Mo.	9 Mo.	12 Mo.
Glazed	1a) Marathon High Gloss SB Carton No Overwrap.	1.9%	4.0%	5.9%	6.4%
	1b) Marathon High Gloss SB Carton Cellophane Overwrap.	0.0	0.0	0.4	0.3
	1c) Marathon High Gloss SB Carton Tyton Overwrap.	0.1	0.2	0.4	0.6
	2a) Commercial Stapled High Gloss Carton No Overwrap.	2.1	6.0	6.5	12.2
Unglazed	1a) Marathon High Gloss SB Carton No Overwrap.	2.0	5.2	4.3	7.0
	1b) Marathon High Gloss SB Carton Cellophane Overwrap.	0.1	0.0	0.1	0.2
	1c) Marathon High Gloss SB Carton Tyton Overwrap.	0.0	0.3	0.3	0.2

Figure No. 1

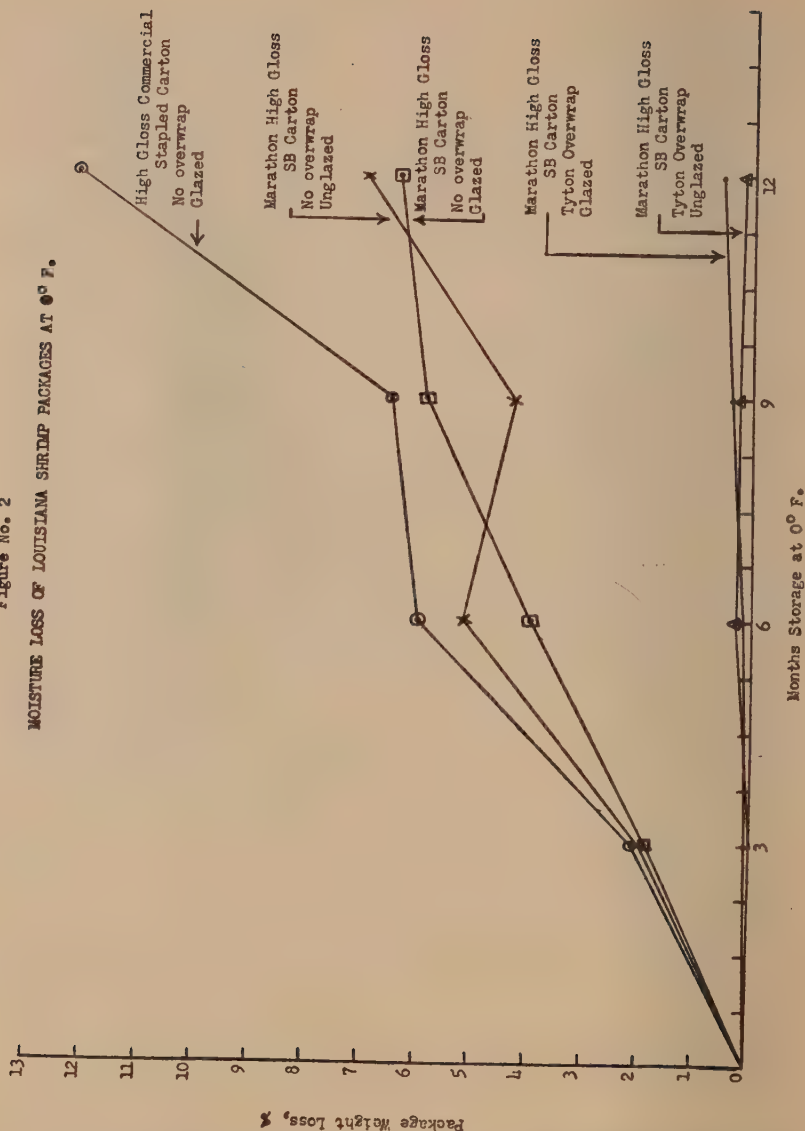
MOISTURE LOSS OF TEXAS SHRIMP PACKAGES AT 0° F.



The weight losses were on the basis of the total package weight, which included shrimp, glazing water (if any), carton and overwrap, if any. It was impractical to determine moisture loss on the shrimp alone because of the glazing water. The moisture loss data are plotted in Figures 1 and 2. The difference in protection obtained on the two sets of samples was probably due to differences in carton construction and in the amount of glazing (Louisiana glazing was heavier.)

Figure No. 2

MOISTURE LOSS OF LOUISIANA SHRIMP PACKAGES AT 0° F.



C. One of the increasingly important factors in packaging of frozen foods is the visual appearance of the product to the housewife. As the use of frozen foods, and particularly of household freezers, becomes widespread, more and more people are learning the significance of "freezer burn", or loss of moisture (desiccation) of frozen foods. Therefore, close observations were

made of the visual appearance of the shrimp in the various packaging combinations.

At three months the glazed packages were still in good condition with only slight desiccation. Shrimp in the overwrapped packages were in excellent condition. After six, nine, and twelve months the shrimp in the stapled commercial carton were badly desiccated, with the glaze partially evaporated. The packages of Louisiana shrimp were less affected than the Texas shrimp, presumably because of the heavier glaze on the former. The overwrapped packages were all in excellent condition, with slight desiccation only on a few surface shrimp and at the corners. The visual observations of desiccation and loss of glaze correlated exactly with the weight losses (Table 1, and Figures 1 and 2).

The top surface of the shrimp in the present commercial package showed a noticeable loss of glaze and desiccation after twelve months of storage. By comparison, the unglazed shrimp packaged in a Tyton overwrapped carton showed only slight surface desiccation after a similar period of time.

The length of time required to defrost five pounds of frozen shrimp under running water (50°F.) is shown in Table 2 for glazed and unglazed samples. The data show that elimination of the ice glaze considerably reduced the

Table No. 2
Defrosting Time of Five Pound Packages of Frozen Shrimp
Using Running Water At 50°F.

Type Pack	Defrosting Time (minutes)
Texas brown shrimp, glazed	45
Texas brown shrimp, not glazed	20
Louisiana white shrimp, glazed	70
Louisiana white shrimp, not glazed	45

defrosting time. The difference between the thawing times of Texas and Louisiana shrimp was probably due to the variation in the amount of ice glaze on the two sets of packages, since the Louisiana shrimp had a heavier glaze.

E. The taste tests on shrimp newly shipped from the Gulf indicated that both Texas and Louisiana shrimp were tender, sweet, juicy, and of mild flavor. There was a definite difference in both flavor and texture of the brown and white shrimp, which was attributed to the difference in species and size.

At three months there was little change in any of the shrimp, by taste and texture comparison. At six, nine, and twelve months the shrimp in cartons which had suffered high moisture loss were slightly tough and less juicy than the freshly frozen shrimp, but there was no off-flavor development, either from oxidation or other cause.

At twelve months both glazed and unglazed shrimp from overwrapped packages were tender and juicy with good flavor, however, there was a slight loss of sweetness in all shrimp. Using blindfold tests, the panel was unable to distinguish between glazed and unglazed shrimp packaged with an over-wrap.

The following conclusions have been reached in this study:

1. Unglazed shrimp can be packed successfully for twelve months storage at 0°F., in a high gloss waxed carton with a satisfactory overwrap. Glazing is not necessary for protection.
2. "Tyton" waxed paper overwrap was as good as the cellophane overwrap from a protective standpoint. The cellophane overwraps were badly damaged during shipment of finished packages whereas the Tyton overwraps withstood shipment without damage.
3. Taste testers could not distinguish between glazed and unglazed shrimp from overwrapped packages. These shrimp were tender and juicy with good flavor, although there was a slight loss of sweetness at 12 months. Glazed and unglazed shrimp from packages without overwrap were slightly tough, with no off-flavor. The texture change appeared to be the main adverse factor resulting from loss of moisture.
4. Elimination of glazing reduced the defrosting time of a five pound frozen shrimp block approximately 36 to 55 per cent.
5. The shipping weight of a corrugated fiber board box, containing ten five-pound packages of frozen shrimp, was reduced fifteen pounds (approximately 21 per cent) by elimination of the glazing process.
6. Glazed shrimp, packaged without an overwrap, showed high weight losses, disappearance of ice glaze, and desiccation of surface shrimp.
7. When tested without overwraps, Marathon shrimp cartons provided considerably more protection for glazed shrimp than the present commercial, stapled cartons.

The laboratory test results have been confirmed by the experience of a number of shrimp packers who have completely converted their packaging line to handle unglazed shrimp in a carton-overwrap combination.

Literature Cited

- ANONYMOUS, 1950. *Mexico's Pacific Shrimp* (1) *The Process of Packing*, (2) *Packaging—the Key to Quality in Pacific Frozen Shrimp*. Pacific Fisherman, 48, No. 10: 42, 43, 45, 47, 74, and 77.
- ANONYMOUS, 1951. *Seafood a la Color*. Modern Packaging, 24, No. 10: 102.
- DIVERS, EARLE L., 1953. *Practical Aspects of Shrimp Freezing*. Proc. Gulf and Carib. Fisheries Instit., 5th Annual Session. Marine Lab., Univ. of Miami, Coral Gables, Fla.: 54-56.
- FIEGER, E. A., 1950. *Problems in Handling Fresh and Frozen Shrimp*. Food Technology, IV, No. 10: 409-411.
- FIEGER, E. A., GREEN, M., LEWIS, H., HOLMES, D., and DuBOIS, C., 1950. *Shrimp Handling and Preservation*. Refrigerating Engineering, 244-247, 286-287.

Comparison of Objective Tests for Quality of Fresh and Frozen Gulf Shrimp

E. A. FIEGER and J. J. FRILLOUX

Department of Agricultural Chemistry and Biochemistry
Louisiana State University
Baton Rouge, Louisiana

The goal of the food technologist has been the development of simple rapid objective tests for evaluating the quality of both fresh and frozen foods. In

spite of intensive research no completely satisfactory objective test has been developed to replace organoleptic or taste panel tests for quality. Objective tests would be particularly valuable in the seafood industry, since the catch could be purchased on the basis of quality. It would aid the wholesale dealers and processors in determining and maintaining quality. The consumer would obtain a better product and this in time would create a greater demand for seafood. Thus the whole industry would be benefitted.

During the summer of 1952 freshly caught headless shrimp were stored in ice and examined daily for quality by certain objective tests. During one of these series of tests, shrimp of varying ice storage ages were packaged, frozen, and stored at 0°F. for 12 months. This is a report of the results obtained upon objectively and subjectively testing both the ice stored and the frozen stored shrimp.

Methods

The shrimp used in this study were brown shrimp (*Penaeus aztecus*) and were caught in the Gulf of Mexico 12 to 16 miles south of the west end of Grand Isle, Louisiana, in 12 to 16 fathoms of water. They were a composite taken from two drags caught at 2:30 AM and 5:30 AM. Within one hour after catching the shrimp had been headed, thoroughly washed with sea water, and packed in crushed ice. The shrimp arrived at the laboratory at 6:00 PM, at which time they were washed in cold water, then packed in a single layer in ice in a wooden box 24 x 28 x 36 inches and stored in a refrigerated room at 38°F. (3.3° C.). The layer of ice beneath the shrimp was sufficiently thick so that it was unnecessary to repack the shrimp during the course of the experiment; ice was added when necessary, however, to maintain several inches of ice on top of the shrimp. The temperature of the storage room caused sufficient ice to melt to prevent the serious development of black spots (Fieger, 1952) and to maintain the shrimp at 32° F. (0° C.). For the frozen stored samples, shrimp which had been held for 24 hours, six days and 12 days in ice were removed, washed in ice water, then placed in one-piece Marathon cartons, overwrapped with Tyton and heat sealed. They were then frozen in a plate freezer at -40° F. (-40° C.) and after 24 hours were placed in 0° F. (-18.8° C.) storage. Chemical, bacteriological and organoleptic studies were made daily on samples taken from ice stored freshly caught headless shrimp and for the frozen storage investigation monthly samples were used during a 12 month period. The shrimp were not washed or peeled after taking the sample. For both series of samples the chemical determinations included the following: tyrosine reaction (Wood, Sigurdson and Dyer 1942), amino nitrogen (Pope and Stevens 1939), trimethylamine nitrogen (Dyer, 1945) and volatile acids (Friedmann, 1938). The bacteriological examination consisted in determining total plate counts (Green, 1949). For the organoleptic test, daily ice stored samples were placed in Marathon one piece telescope cartons, overwrapped with Tyton, frozen and stored at -40°F. (-40°C.). At the termination of the experiments the shrimp were thawed, cooked in tap water for a total boiling time of eight minutes, and panel tasted by four experienced judges. The frozen stored samples were similarly cooked at each date of sampling.

Experimental Results

Ice Storage Studies

Five separate experiments in which freshly caught shrimp were stored in ice were undertaken. Although the five lots of shrimp were caught in different locations, were of different size count, and were in one case brown shrimp while the other four were white shrimp (*Penaeus setiferus*), the analytical data were consistent. Data will be presented, therefore, only for the brown shrimp. Two advantages of using these data are that samples have been frozen and analyzed, as previously mentioned, and that accurate information of their history is on record.

Of the chemical tests used, the values for the tyrosine reaction showed no definite trends. It was concluded that this test was of no value as an indicator of quality or length of storage of fresh headless Gulf shrimp.

The values for both trimethylamine nitrogen and volatile acids are of limited usefulness as a measure of quality or length of storage of shrimp. During the first nine to 14 days in the case of trimethylamine determinations and 11 to 17 days for analysis of volatile acids, both gave values which remained relatively constant (Table 1). After this initial period both gave values which increased significantly, and lagged two or three days behind a similar increase in total bacterial plate counts. The initial rise in trimethylamine values corresponded to a plate count of 25,000,000.

TABLE 1
COMPARISON OF CHEMICAL BACTERIOLOGICAL AND
ORGANOLEPTIC TESTS OF ICE STORED SHRIMP

Length of Ice Storage (days)	Trimethylamine Nitrogen Mg. per 100 g. Shrimp	Volatile Acids ML. .01N NaOH per 100 g. Shrimp	Amino Nitrogen Mg. per 100 g. Shrimp	Bacterial Plate Counts X 10 ⁶ per g. Shrimp	Organo- leptic Score
1	0.3	47	333	0.5	12
2	1.0	20	396	2.5	11
3	0.3	21	318	2.8	11
4	0.9	18	278	2.6	11
5	0.6	20	297	0.1	11
6	0.4	38	276	0.8	8
7	0.6	23	303	0.7	8
8	0.7	18	272	0.7	6
9	0.4	18	253	1.6	7
10	0.5	19	251	3.0	6
11	0.6	18	230	4.2	7
12	1.0	25	238	28.6	7
13	1.5	26	227	46.0	7
14	2.0	24	210	57.0	4
15	3.4	35	186	44.0	2
16	5.4	29	118	190.0	3
17	6.9	44	196	107.0	4

The chemical test which appeared to have greatest merit was the determination of amino nitrogen. These values decreased in magnitude as the length of ice storage time increased (Table 1). It is to be noted, however, that rather wide fluctuations occurred in the values obtained,

particularly during the early period of storage. The decrease in the values for amino nitrogen reported here agree with similar changes reported by Beatty and Collins (1939) in their studies on press juice from cod tissue. They are opposite, however, to that reported by Campbell and Williams (1952) for shrimp, and Sigurdsson (1947) for herring, both obtaining increases in amino nitrogen during refrigerated storage. Beatty and Collins (1939) found the decrease in amino nitrogen approximately equals the increase in ammonia nitrogen and they suggest that bacterial de-amination of amino acids liberated from tissue proteins would account for the results obtained. It should be pointed out that in all our experiments on ice storage of freshly caught shrimp the amino nitrogen values decreased with increased storage time.

The results of taste panel experiments showed that the palatability and flavor of the shrimp decreased slightly during the first five days of storage (Table 1). Following this initial period a sharp break in the curve occurred and by the eighth day the shrimp had lost their characteristic sweet shrimp flavor. During the following seven-day period they were flat tasting and no off flavors associated with spoilage were noted. The cooked meats did not have the opaque white appearance of cooked fresh shrimp, but rather a faint bluish translucent appearance, which one would associate with insufficiently cooked shrimp. This second period was followed by another sharp break in the flavor curve. At this time off flavors were evident and in our opinion these shrimp were inedible.

For evaluating early stages of storage of shrimp, the measurement of trimethylamine nitrogen or volatile acids is of limited value. Only after spoilage has occurred, as shown by organoleptic tests or visual observation, are these tests of value. It is contended that in control work, there is little value in any test which is valid only after definite organoleptic evidence of spoilage. Dyer and Dyer (1949) consider a level of 15 mg. of trimethylamine nitrogen per 100 g. of cod fillet tissue the borderline between acceptance and rejection. Stander, Grewe, Marks and Rowan (1951) state that for stock fish stored in air at 32°F. (0°C.) the first suggested odor change occurred in the range of 6-15 mg. trimethylamine nitrogen per 100 g. of fish. Above 15 mg. the fish were definitely spoiled. When fish were stored in ice, considerable leaching of trimethylamine occurred, and after nine days, when the fish had an off odor the trimethylamine values ranged between two and 10 mg. With shrimp stored as indicated above, off odors and spoilage were evident when the trimethylamine content reached 1.5 mg. nitrogen per 100 g. of shrimp. With respect to volatile acids, the break in the curve occurred one to two days later than for trimethylamine. With unspoiled shrimp neither of these tests are of value in denoting how long the shrimp have been stored, their future probable storage life, or their quality at the time of sampling.

For amino nitrogen the following tentative value are suggested as indicators of probable length of ice storage: greater than 275 mg. amino nitrogen per 100 g. shrimp, 0 to 8 days; 275 to 200 mg., 8 to 14 days; 200 to 150 mg., 14 to 17 days and less than 150 mg. longer than 17 days. The above values apply to shrimp of 28 count per pound. For shrimp of smaller sizes, values for amino nitrogen were somewhat lower so that the suggested values will have to be used with reservation.

From his studies of iced white fish Shewan (1951) divided the course of spoilage into four phases. During the first phase of 0 to 6 days there was no marked spoilage. In the second phase of 6 to 12 days the first definite signs of spoilage became evident. These consisted of softer flesh, staler appearance and strengthening of the odor. From 12 to 16 days these become more intense and are designated the third phase. In the fourth phase of 16 days and longer, rapid deterioration from staleness to putridity occurred. For ice stored shrimp it is suggested that the progressive changes in quality be divided into three phases or stages. During the first period of 0 to 7 days of storage the shrimp gradually lose their characteristic sweet flavor. The flesh of the cooked product is firm and has an opaque white color. The second stage from the eighth to the 14th day of storage is characterized by a tasteless product, the cooked meat is softer and its color changes to a very faintly bluish opalescent appearance. Cooking these shrimp for 30 minutes in boiling water does not change their appearance to the opaque white of fresh shrimp of phase one. In phase three, over 14 days storage, rapid deterioration occurs. The shrimp are softer and off odors of amines become pronounced. At the present time the shrimp industry is attempting to improve the quality of shrimp products placed on the market. The result reported here show that prime quality fresh shrimp, which have the characteristic sweet flavor of the freshly caught product, can result only when the shrimp are ice stored for periods shorter than seven days. If stored for eight to 14 days the consumer will obtain a product poorer in flavor, appearance and texture. These recommendations for storage time are more stringent than those recently suggested by Campbell and Williams (1952).

On the basis of the evidence presented, two types of changes are postulated to account for loss of quality and spoilage of shrimp. One of these causes loss of the sweet flavor and some softening of the tissue. These changes predominate during the first seven days of ice storage and probably are catalyzed by tissue enzymes and can be designated as tissue autolysis. While loss of quality progresses during this period spoilage has not occurred. This indicates there is no ripening process such as occurs with meat. The other type of change predominates during the later storage period and results from the multiplication of bacteria. Some of the products of bacterial action give to the shrimp the odors and flavors associated with spoilage.

Frozen Shrimp Results

The results of the frozen shrimp study for all three samples showed that no significant changes occurred in the values obtained for the tyrosine reaction, volatile acids or amino nitrogen determinations during 12 months of frozen storage. Of the trimethylamine-nitrogen determinations the 24 hours ice storage sample showed no change over the same period of frozen storage, the values fluctuating between 0.2 and 0.6 mg., average 0.44 mg., of trimethylamine nitrogen per 100 g. of shrimp. A similar range in values was obtained for the six days ice storage sample during the first six months of storage, with longer periods of frozen storage the values fluctuated around one mg. The average over the 12 months period was 0.56 mg. For the 12 days ice storage sample, the trimethylamine nitrogen values fell

from an initial amount of 1.2 mg. to a low of 0.7 mg. after four months storage and then rose maintaining values which fluctuated around 1.5 mg. per 100 g. shrimp, the average value for these samples was 1.26 mg. It should be noted that in raw shrimp as well as in frozen shrimp the odor of trimethylamine can be detected with values as low as 1.5 mg. trimethylamine nitrogen per 100 g. shrimp.

The bacterial plate counts for both the 24 hour and six days ice storage samples remained in the low ten thousands after the first month of frozen storage. With the 12 days ice storage sample, however, the count was considerably higher and fluctuated quite widely, probably because of the variable quality of the individual shrimp at the time of packaging and freezing.

With frozen shrimp the subjective organoleptic test was the best quality indicator of the methods studied. During the first seven months of frozen storage, the 24 hour ice storage sample gradually lost its characteristic sweet flavor. The six days ice storage sample, however, had become tasteless after three months of frozen storage. During the remainder of the frozen storage period for both samples the shrimp were tasteless, and no off flavors were evident. At each time of sampling, however, the 24 hour ice storage sample rated better than the six days ice storage sample. Since the 12 days ice storage sample had lost its sweet shrimp flavor prior to freezing, it was rated of poorer quality than the other two samples at each time of testing. They were tasteless the first nine months of frozen storage and then developed a bitter taste on longer storage. From these results it is evident that the length of time shrimp are stored in ice prior to freezing affects both the quality of the frozen product and the length of time they remain an acceptable product during frozen storage.

Summary

Chemical, bacteriological and organoleptic studies were made daily on samples taken from ice stored fresh headless shrimp, and monthly on samples of these same shrimp which had been frozen after 24 hours, six days and 12 days ice storage.

On the ice stored fresh headless shrimp the tyrosine reaction was shown to be of little or no value as an indicator of quality. Determinations of trimethylamine nitrogen and volatile acids were of value in indicating whether spoilage had occurred, but did not give information of pre-spoilage changes. Significant increases in bacterial plate counts preceded by two or three days similar increases in volatile acids and trimethylamine nitrogen values. Amino nitrogen values decreased with increasing length of ice storage and correlated quite well with taste panel tests of flavor and quality.

The results of our taste panel studies showed that during the first five days of ice storage the shrimp retained their characteristic sweet flavor. During the sixth and seventh days of ice storage there was a rapid loss of flavor and from the eighth to the 14th day they were characterized by being flat tasting. Beyond 14 days storage spoilage occurred with the simultaneous development of off flavors. It is postulated that loss of quality during the early period of ice storage is caused mainly by autolysis and with longer storage spoilage occurs mainly through bacterial action.

On the frozen samples no significant changes occurred in the values

obtained for the tyrosine reaction, the amino nitrogen or the volatile acids determinations during 12 months of frozen storage for the three series of samples. A small increase in the amount of trimethylamine nitrogen was observed for the six days and 12 days ice storage samples after seven and four months of frozen storage respectively. No change was obtained, however, for the 24 hour ice storage sample. It is concluded that none of the objective chemical tests studied are of value in indicating changes in quality of stored frozen shrimp. Bacterial plate counts are also of doubtful value, a very high count, however, would indicate that the shrimp were of poor quality at the time of packaging and freezing. The converse is not necessarily true, namely, that a low plate count indicates shrimp of high quality.

Of all the tests studied, the subjective organoleptic or taste panel test was the only one which revealed changes in quality during frozen storage. The 24 hours ice storage samples retained their sweet flavor during seven months of frozen storage, while the six days ice storage samples had become tasteless after three months of frozen storage. The 12 days ice storage samples were tasteless the first nine months of frozen storage and then developed a bitter taste on longer storage.

From these results it is evident that changes induced by bacteria or catalyzed by enzymes are proceeding too slowly at 0°F. (-18.8°C.) to be used to measure modification in quality. This also explains why foods retain their quality during relatively long periods of frozen storage.

Literature Cited

- BEATTY, S. A., and COLLINS, V. K., 1939. Trimethylamine and spoilage. *J. Fisheries Research Board Can.*, 4, 412-423.
- CAMPBELL, JR., L. L., and WILLIAMS, O. B., 1952. The bacteriology of Gulf Shrimp IV. Bacteriological, chemical and organoleptic changes with ice storage. *Food Technol.*, 6, 125-126.
- DYER, F. E., and DYER, W. U., 1949. Changes in the Palatability of Cod Fillets. *J. Fisheries Research Board Can.*, 7, 449-460.
- DYER, W. J., 1945. Amines in fish muscle. 1. Colorimetric determination of trimethylamine as the picrate salt. *J. Fisheries Research Board Can.*, 6, 351-358.
- FIEGER, E. A., 1952. Studies on black spotted shrimp. *Proc. Gulf and Carib. Fish. Inst. Fourth Ann. Session*: 79-82.
- FRIEDMAN, I. E., 1938. Identification and quantitative determination of volatile alcohols and acids. *J. Biol. Chem.*, 123 161-184.
- GREEN, M., 1949. Bacteriology of shrimp I. Introduction and development of experimental procedure. *Food Research* 14 365-371.
- POPE, C. G., and STEVENS, M. F., 1939. Determination of amino nitrogen using a copper method. *Biochem. J.* 33, 1070-1077.
- SHEWAN, J. M., 1951. Recent progress in the handling, storage and transport of iced white fish. *The Fishing Bulletin* 1 8.
- SIGURDSSON, G. J., 1947. Comparison of chemical tests of the quality of fish. *J. Ind. Eng. Chem. Anal. Ed.* 19 892-902.
- STANDER, G. H., GREWE, F. J., MARKS, R. H. and ROWAN, A. N., 1951. Preservation of stock fish. Report 1950-51 of the Director. Fishing Industry Research Institute. Union of South Africa.
- WOOD, A. J., SIGURDSSON, G. J., and DYER, W. J., 1942. The surface concept in measurement of fish spoilage. *J. Fisheries Research Board Can.* 6 53-62.

The Use of Ultraviolet ("Black") Light for Determining Quality in Iced Shrimp¹

CHARLES E. LANE and B. EDWARD WHITTAKER

The Marine Laboratory, University of Miami, Coral Gables, Florida

One of the most urgent needs in the shrimp industry is for a rapid and accurate method of testing the quality of iced shrimp. This method must be free from the errors of personal opinion. The industry suffers through the inability of buyers to recognize spoiling shrimp with sufficient accuracy. Lacking objective tests of quality, penalties in the form of lower prices cannot be imposed for poorly handled catches. On the other hand, bonuses cannot be offered careful fishermen or other workers for high quality raw material.

This problem has been studied by scientists of The Marine Laboratory of the University of Miami, as part of the Laboratory's research program for the Florida State Board of Conservation, and for the Quality Control and Research Committee of the Shrimp Association of the Americas.

Work in this laboratory, as well as that reported by others, has indicated that results of standard chemical tests cannot be used to show deterioration in quality of stored shrimp. Thus results of tests for indole, skatole, amino nitrogen, total nitrogen, glycogen, total fat and pH varied independently of simultaneous quality scored by the taste panel.

It was therefore determined to study changes in the fluorescence induced by ultraviolet ("black") light in iced shrimp. It was first observed that the chitinous exoskeleton or shell of the shrimp was intensely fluorescent. This fluorescence is brilliant white and effectively conceals any changes occurring in underlying tissues. It was observed that peeled newly caught shrimp exhibited a purple-blue fluorescence. In shrimp stored for varying periods of time in ice a progressive change in fluorescence was observed. The purple-blue of the fresh shrimp is gradually replaced by an off-white fluorescence which increases in amount with increased time of storage. The white fluorescence appears first at the anterior, or headed, end of the shrimp. This color also appears at breaks in the shell or at the bases of the appendages. It is usually more evident on the ventral (under side) than on the dorsal side.

The ultraviolet light source used in these experiments was one in which considerable visible light was also emitted. Peak transmission was at 2570 angstroms.

Any shrimp, when peeled and exposed to ultraviolet light in the neighborhood of 2570 angstroms, which shows brilliant white fluorescence of the tissue at the headed end, or elsewhere, may be graded as spoiled or rapidly spoiling. A faint white fluorescence in the headed region indicates the first onset of spoilage. In our experience this has generally occurred in from six to ten days when the shrimp have been held in "Rickey" type ice.

It is anticipated that buyers may use this method, using the ultraviolet light to test samples of shrimp taken from catches at the dock, or from shipments of iced shrimp delivered to processing plants.

¹ Contribution No. 123. The Marine Laboratory, University of Miami.

Further Experiments In Holding of Fresh Shrimp In Refrigerated Sea Water and Ice¹

J. B. HIGMAN, C. P. IDYLL and JAMES THOMPSON

The Marine Laboratory, University of Miami, Coral Gables, Fla.

At the 1952 meeting of the Gulf and Caribbean Fisheries Institute, the Marine Laboratory of the University of Miami presented results of experiments in the use of refrigerated sea water for holding fresh shrimp aboard fishing vessels (Higman & Idyll, 1953). It was reported that shrimp held in sea water chilled to 29°-32°F. were superior to shrimp held in crushed ice, in terms of flavor and appearance. Melanosis, or black spotting, was eliminated. A weakness of the method was the development of undesirable odors in the sea water-held shrimp.

Since that time further experiments have been conducted with the sea water method, principally to combat the odor problem. In addition, tests were run with ice-held shrimp in order to develop methods of eliminating the serious problem of black spotting.

In the sea water experiments several methods were tried in an attempt to eliminate odor. No improvement in quality resulted from changing various volumes of the refrigerated sea water. Further, the odor was not improved by the addition of any of the following: sodium hypochlorite, calcium hypochlorite, sodium bisulfite, Fram Kem, (a trade name for a mixture of fumaric acid and sodium benzoate), and Movidyne, (a trade name for a colloidal suspension of silver).

However, after these negative results, progress has been made in the control of odor by using the antibiotic, aureomycin hydrochloride.

Experiments were conducted in which one, five, eight, 10 and 20 p.p.m. of aureomycin hydrochloride were added to the refrigerated sea water in which freshly caught shrimp were being held. In each experiment pink shrimp (*Penaeus duorarum*) from the Tortugas grounds were used. At intervals tests were conducted comparing aureomycin-treated shrimp with shrimp held in untreated refrigerated sea water. The test panel rated the shrimp as to taste, odor and toughness. A five-point scale was used in rating the shrimp. The maximum rating was 5.0, and descending scores indicated shrimp of lower quality. For the purpose of these tests an arbitrary score of 3.5 was established for "good" shrimp. Lower scores were considered to indicate unacceptable shrimp.

In these experiments the taste and toughness scores for aureomycin-treated shrimp were similar to, but generally slightly higher than, the scores for untreated shrimp. These differences, however, were never great enough to be statistically significant.

Concentrations of aureomycin below five p.p.m. were ineffective in eliminating the undesirable odor.

At 10 and 20 p.p.m. the antibiotic inhibited the odor, but caused a slight yellowish coloration on the shrimp muscle. This color was accentuated when the shrimp were boiled.

Three separate experiments at concentrations of five p.p.m. of aureomycin hydrochloride and two experiments at eight p.p.m. have been

¹ Contribution No. 112. The Marine Laboratory, University of Miami.

ODOR

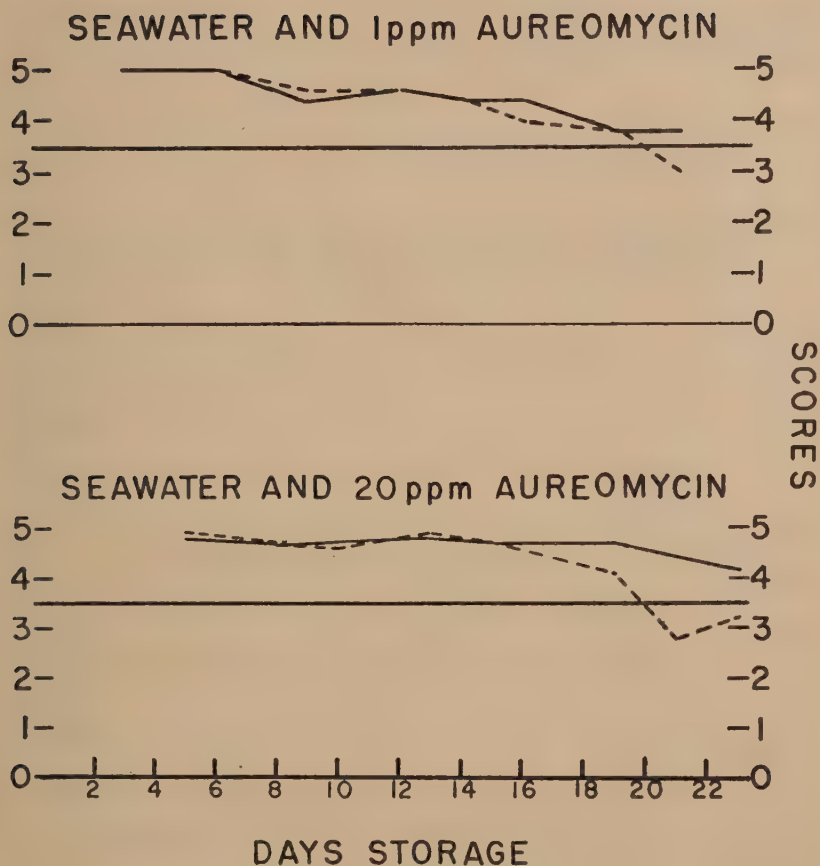


Fig. 1.

conducted. The results show that five p.p.m. concentration is the smallest concentration of antibiotic which inhibited odor without causing slight coloration (Figures 1 to 4).

The odor of the sea water in which shrimp were held was checked during the experiment. Undesirable odors were detected in the water two to three days before the test panel rated the odor of the shrimp objectionable.

No commercial use of these results is possible at present because of the prohibition by the Food and Drug Administration against the use of antibiotics in food. This ruling may be altered in the future.

ODOR

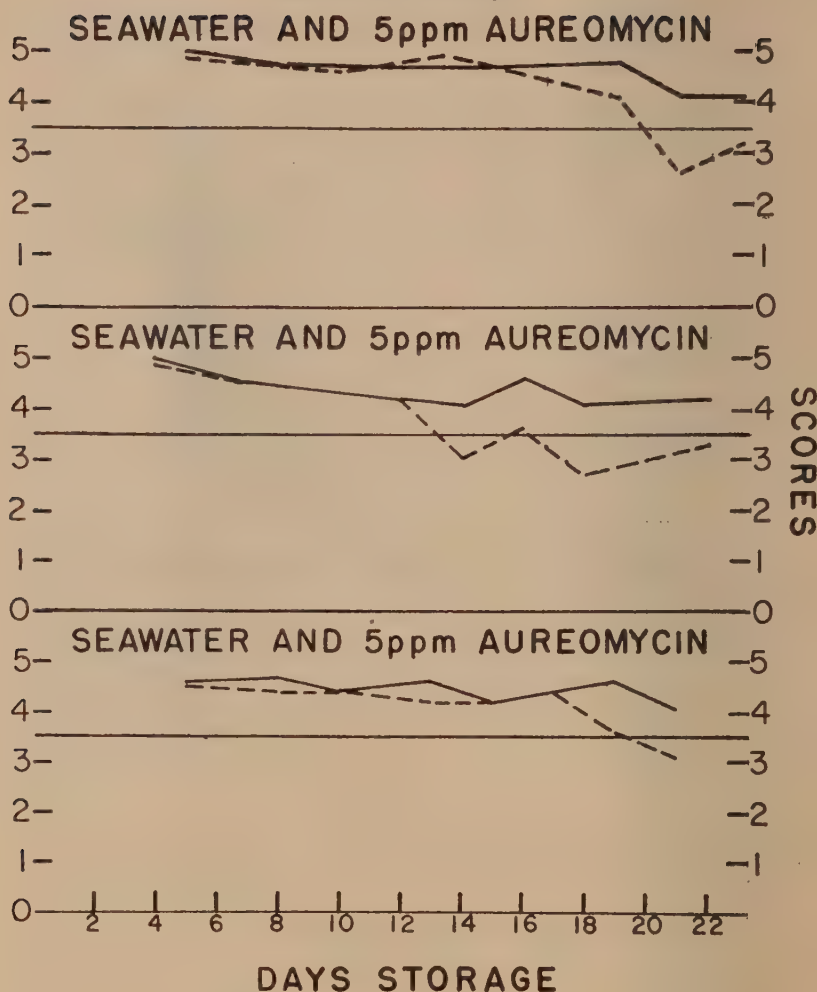


Fig. 2.

A second series of experiments has been designed to test improved methods of carrying shrimp in crushed ice.

The possible effect on quality of different sizes of ice particles was first tested. Shrimp taken from vessels fishing the Tortugas grounds were held at the Marine Laboratory in ice of three sizes. These were "snow" ice, such as is commonly used at present aboard the boats, "rickey" ice, in which the sizes of particles are larger than snow ice, and "flake" ice. No measurable differences in quality were detected in shrimp held in these three types of ice.

ODOR

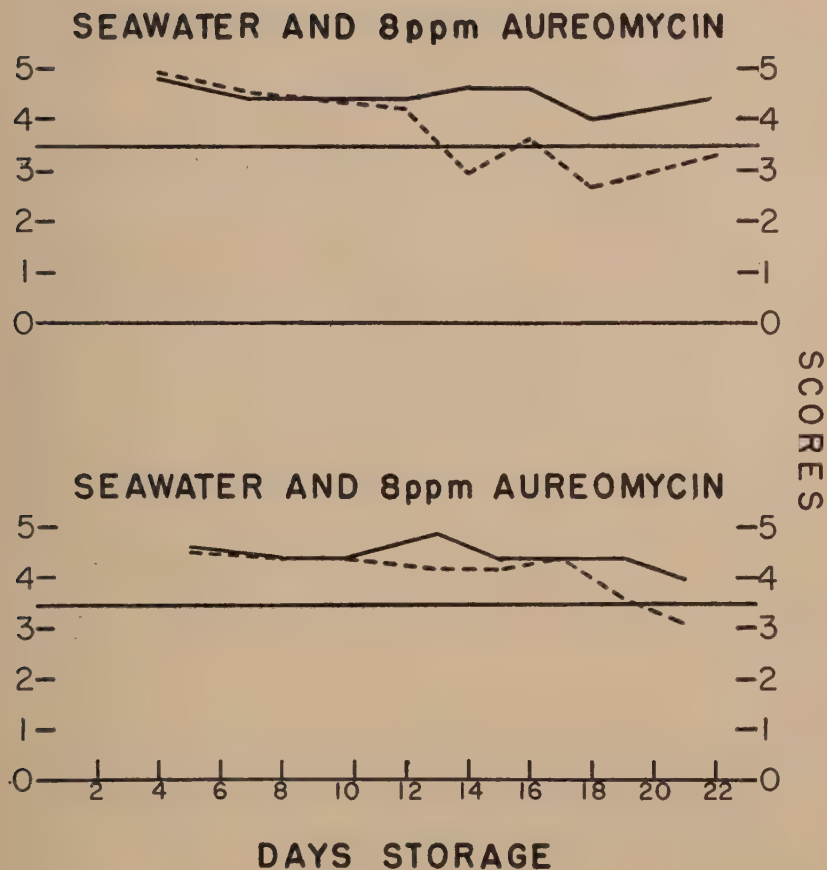


Fig. 3.

Tests were also conducted in attempts to reduce melanosis, or black spotting, of shrimp held in ice. Ascorbic acid and sodium bisulfite were tested. The ascorbic acid was ineffective, but promising results were obtained with sodium bisulfite in concentrations of one, two and one-half and five per cent. (See Figures 5 to 7.) A measurable reduction in the black spotting resulted in all cases but the best results were obtained with the two and one-half per cent solution. After the shrimp were headed and washed in the usual way aboard the fishing boat, they were dipped for about one minute in

ODOR

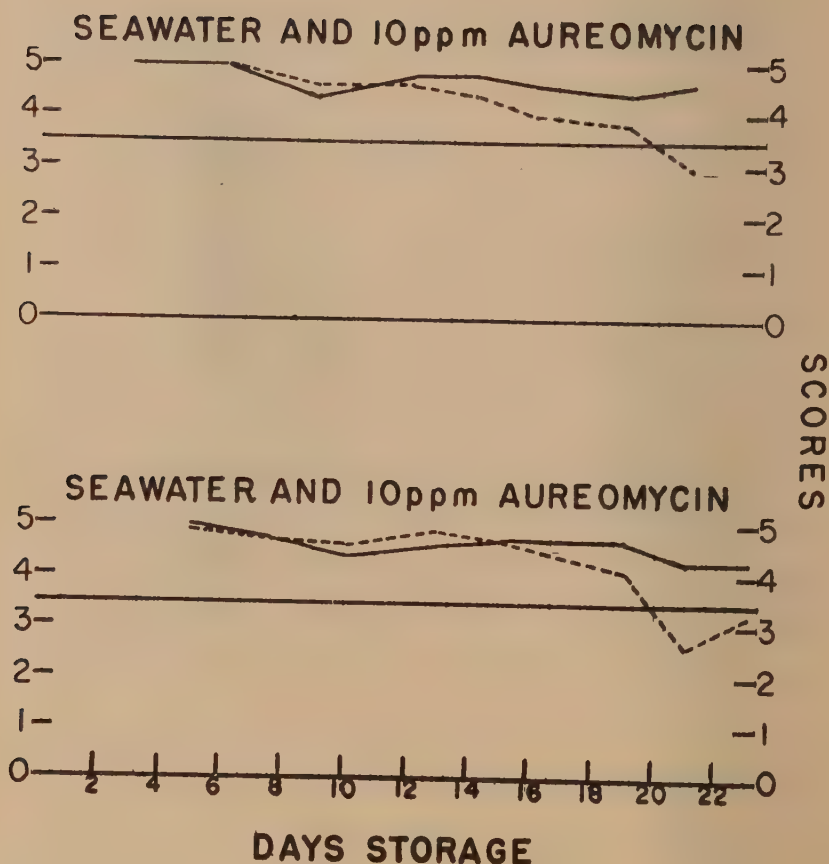


Fig. 4.

the sodium bisulfite solution. The shrimp were iced in the conventional manner. The experiments were then continued at the Laboratory, the shrimp being held in insulated ice bunkers. After seven to eight days they were dipped a second time in two and one-half per cent bisulfite solution. Shrimp dipped only once were not as good as those dipped twice. In commercial practice the second dip would probably be done at the dock, the wash water in the tanks being a solution of sodium bisulfite rather than plain water.

Organoleptic tests comparing treated and untreated samples were made in

BLACK SPOT

2½ % SODIUM BISULPHITE

DIPPED ONCE

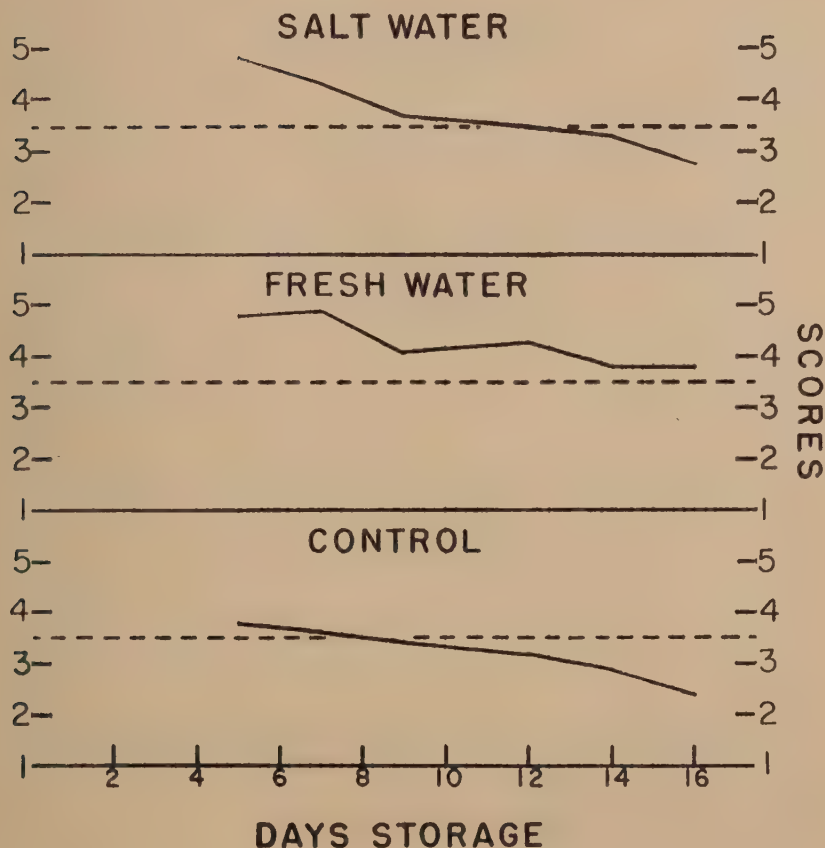


Fig. 5.

the manner described for sea water-held shrimp. The test panel rated the shrimp for taste, odor, toughness and development of "black spot."

Tests of untreated and bisulfite dipped shrimp show that there are no significant differences in taste and toughness among these samples. There is some evidence of better odor among bisulfite-treated shrimp.

Again, this chemical has not yet been approved for use by the Food and Drug Administration.

BLACK SPOT

2 ½ % SODIUM BISULPHITE
DIPPED TWICE

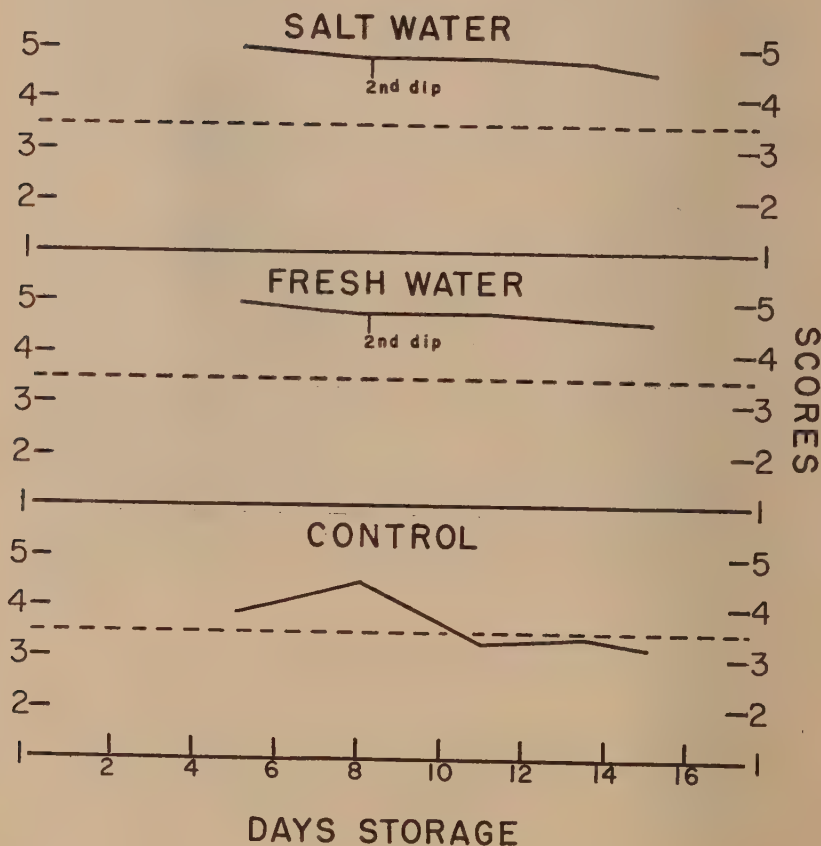


Fig. 6.

In summary, the following results are reported.

1. Repeated tests have confirmed that shrimp held in refrigerated sea water are as good as or superior in quality, with the exception of odor, to shrimp held in crushed ice.
2. Concentrations of five to 10 p.p.m. aureomycin hydrochloride eliminated the undesirable odors of shrimp held in refrigerated sea water.
3. No measurable differences in quality could be detected among shrimp held in three sizes of ice particles.

BLACK SPOT

2 ½% SODIUM BISULPHITE

DIPPED TWICE

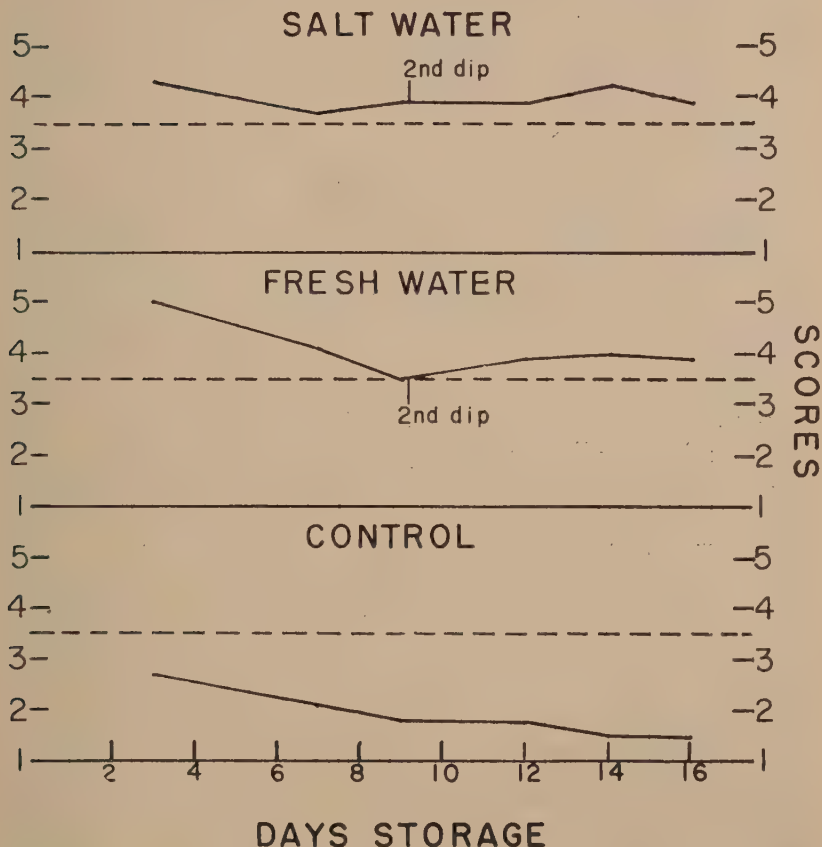


Fig. 7.

4. Shrimp dipped twice in two and one-half per cent concentrations of sodium bisulfite showed marked reduction in the amount of melanosis, or black spot, after being held in ice.

REFERENCE

HIGMAN, JAMES B. and C. P. IDYLL, 1953. *Holding Shrimp in Refrigerated Seawater*. Proc. Gulf & Caribbean Fisheries Institute, 5th Annual session, University of Miami, Marine Lab. pp. 41-53.

Freezing Gulf of Mexico Shrimp At Sea

JOHN A. DASSOW

Chief, Fishery Products Laboratory, Fish and Wildlife Service,
Ketchikan, Alaska

The increasing development of the shrimp fishery in the Gulf of Mexico and other southern waters has brought new technological problems to the industry in recent years. Expanding shrimp markets brought more and larger vessels with larger payloads. As boats ranged hundreds of miles from port, icing the shrimp over 10 to 12 days created a quality problem. Softening, black spot discoloration, loss of flavor, and spoilage loss in shrimp held too long in ice meant dollars lost to the fishermen and product quality lost to the industry.

Recognition of these problems has encouraged the adoption of better handling practices aboard vessel, improved icing procedures, and hold refrigeration for preservation of ice on the outbound trip. Packaging and freezing the raw headless shrimp aboard vessel appears to be a satisfactory solution to many fishermen with larger boats and investment money to spare. Trials in the last few years have indicated considerable promise for holding fresh shrimp in refrigerated sea water aboard the vessel. (Idyll, Higman and Siebenaler, 1952.) Another approach is the possibility of freezing the shrimp in low temperature brine at sea followed by thawing, packaging and refreezing ashore.

Freezing the packaged shrimp aboard the vessel solves the problem of long trips since even a four to six week trip may be accomplished with no appreciable loss in quality to shrimp properly frozen and stored. The freezing of shrimp in brine aboard vessel appears to offer several excellent advantages compared to other systems. Brine freezers are adaptable to small boats since packaged units may be easily designed for small space requirements. Brine freezing of small and irregular-shaped products such as shrimp is efficient and fast. Complete protection against dehydration (freezer burn) is insured during the freezing cycle as contrasted with air blast freezing. A large volume of cold brine is an excellent reserve of refrigeration during peak periods of fishing. Many of the practical advantages, as well as the problems, of brine freezing fish at sea have been demonstrated by the Fish and Wildlife Service's studies aboard the trawler *Delaware* off the New England coast.

The present study was intended as a small scale trial of brine freezing shrimp at sea in the Gulf of Mexico area, using the facilities of the FWS vessel *Oregon*, which was engaged in exploratory shrimp fishing at the time. Among the factors considered were the handling conditions of the shrimp prior to freezing, freezing of whole and headless shrimp, effect of extended immersion periods in brine, importance of brine circulation, problems of glazing brine frozen shrimp for bulk storage, amount of salt (sodium chloride) absorption in the flesh, effects of thawing and refreezing brine frozen shrimp, and comparison of keeping quality with air frozen shrimp.

Experimental

All freezing trials at sea were conducted aboard the Fish and Wildlife Service vessel *Oregon* during March and April, 1952. Both the white shrimp (*Penaeus setiferus*) and brown shrimp (*P. aztecus*) were brine and air frozen

during exploratory trips off the Mississippi, Louisiana and Texas coasts. In addition, fresh iced white shrimp obtained from the commercial fishery were frozen for comparison. A sample of commercially packaged and frozen brown headless shrimp was obtained for comparative storage tests with the experimental samples. All samples of frozen shrimp were shipped under refrigeration at the conclusion of the work in May, 1952, to the Fishery Products Laboratory, Ketchikan, Alaska, where storage tests and examinations were conducted until February, 1953, when the tests were concluded.

Shrimp processed at sea were brine or air frozen within two hours after catching, with the exception of one lot of whole shrimp which was iced for three days prior to heading and freezing. Both whole and headless shrimp were frozen by the two methods. All shrimp were rinsed thoroughly with clean sea water before freezing. Air frozen shrimp were prepared as the control sample and were packaged in five pound waxed cartons, placed in the sharp freezer at -20° F. for 24 hours, glazed with cold fresh water, and stored at 0° F.

Brine frozen shrimp were prepared by immersing five to 10 pound lots of shrimp for about 15 minutes in circulating 85° salometer brine chilled to 5° F. Using small lots, the brine temperature increased not more than 5° F. during the freezing period. After removing the shrimp from the brine they were drained briefly, rinsed in fresh water chilled to 34° F., drained, packaged in one or five-pound waxed cartons, and stored in air at 0° F. The effect of chilling the shrimp in fresh cold water (34° F.) prior to immersion in the brine was determined. The freezing rate of the shrimp was determined by observation of cut sections of shrimp removed at intervals from the brine and also by use of a metal stem thermometer thrust into the middle portion of individual shrimp. Samples of shrimp for salt penetration tests were taken by allowing particular lots of the shrimp to remain in the brine up to 48 hours and removing small samples (approximately one pound) at intervals from 15 minutes to 48 hours. Observations were made on the importance of brine circulation and methods of keeping the chilled brine in contact with the shrimp. Because of the limited capacity of the experimental brine freezer, no observations were possible on the optimum ratio of volume of shrimp to volume of brine.

The experimental brine freezer was constructed of equipment readily available at low cost in view of the limited time and funds available for this study. A 55-gallon open-top drum was wrapped with two-inch rock wool batts and used for the brine tank. Approximately 60 feet of one-half inch copper tubing was coiled in the bottom of the drum and along the inside, and connected to a one-half horsepower Freon-12 air-cooled refrigeration compressor. A one-quarter horsepower centrifugal pump with neoprene impeller and two-inch heavy duty rubber hose were used to pump the brine from the bottom of the tank to the top where it was discharged directly over the shrimp. Approximately 40 gallons of 85° salometer brine (made up with C-grade mined salt) were added to the tank. A cover was necessary during periods of rough weather to keep the brine from sloshing out. The cover was slotted to allow access for the refrigeration coils and the brine hose. Covered galvanized wire mesh baskets and open mesh cotton bags were used to hold the shrimp during freezing tests. A dial-type metal stem thermometer was used to indicate brine temperature. The brine freezing equipment with an extra drum for a glazing tank was placed amidships in a large refrigerated well maintained at

34 to 38° F. With no freezing load the minimum temperature of the brine at the bottom of the tank was -2° F., and that at the top +2° F.

Whole shrimp which had been brine frozen at sea and stored in air at 0° F. for several weeks were used for thawing and refreezing tests ashore. Preliminary trials indicated that the shrimp could be thawed sufficiently for heading by immersing them 10 to 15 minutes in running fresh water at 60° F. The shrimp were still cold and slightly stiff. After heading, the shrimp were rinsed well with fresh water, packaged in one-pound waxed cartons, and frozen in air at -20° F. The following day the shrimp were glazed in the package with fresh cold water (34° F.) and stored at 0° F. Shrimp which were headed before brine freezing were not thawed and refrozen but were stored for comparison.

Table 1 summarizes the main variables in the samples of shrimp frozen at sea and ashore for storage tests at 0° F.

Table 1. *Shrimp Samples Frozen for Storage Tests*

AF (air frozen)

- | | |
|------------|---|
| 1. Control | Headed, packaged, frozen immediately at sea. |
| 2. Iced | Iced at sea three days, headed, packaged, frozen. |

BF (brine frozen)

- | | |
|-----------------|--|
| 3. Refrozen | Brine frozen at sea, thawed, headed, packaged, and refrozen in air ashore. |
| 4. Not refrozen | Headed, brine frozen, packaged at sea. |

In addition to the above samples, two small lots of commercially caught white shrimp were obtained from Bayou la Batre, Alabama, and Cameron, Louisiana, and frozen in air and in brine ashore. These samples of frozen white shrimp were prepared primarily for salt penetration studies and comparison with the shrimp frozen at sea. For determination of salt (sodium chloride) content, two or more subsamples of six or more shrimp were drawn from each sample lot of shrimp, thawed, and peeled. Each sub-sample of shrimp meat was analyzed for total sodium chloride content by the official procedure of the Association of Official Agricultural Chemists (AOAC, 1950).

Organoleptic examination of the frozen, thawed, and cooked shrimp samples was made after five, eight, 15, 26, and 40 weeks of storage at 0° F. The frozen shrimp were thawed quickly in fresh water and cooked seven minutes in boiling water. Appearance and odor of the thawed shrimp were noted. The cooked shrimp were coded and graded by laboratory taste panels for appearance, flavor and texture. The brown and white shrimp were tested separately in case there were quality differences due to species.

Results

Observations of shrimp handling methods prior to freezing at sea and at shore processing plants indicated that warm temperature, air, and sunshine are the most important factors which cause rapid loss in quality to the shrimp caught in southern waters. Softening and moderate discoloration of the whole shrimp were observed after icing as little as three days. Both at sea and ashore samples of shrimp left in the shade but exposed to warm air for periods of six to eight hours showed similar significant loss of quality. The results of later examinations of the frozen samples reminded us that the best any method of freezing can accomplish is to fix the quality of the product

at the time it is frozen. Quality comparison of the frozen samples was difficult in some cases because limited time and facilities did not permit preparation of the samples under strictly uniform conditions.

After several freezing tests at sea it was apparent that the most effective handling procedure for shrimp prior to freezing was the use of an ice water tank in which the whole or headed shrimp could be chilled immediately after separation from the catch. With the limited capacity of the experimental brine freezer, this preliminary chilling not only minimized the quality loss during delays but also improved the efficiency of the freezing process. Shrimp chilled thoroughly in ice water before immersion in cold brine appeared to freeze faster and had a better appearance. The cold water on the outside of the shrimp tended to freeze as a thin glaze immediately after immersion in the brine. This glaze was noticeable on the surface of such shrimp after removal from the brine.

Observations of shrimp immersed in circulating brine at 5° F. indicated that shrimp averaging 20 to the pound headless would freeze in 10 minutes. Larger shrimp required five minutes longer, or a total of 15 minutes until solidly frozen. Smaller shrimp averaging 35 headless shrimp per pound were frozen in four minutes to an internal temperature of 15 to 23° F. A maximum of eight minutes was required to lower the temperature to about +5° F. Thus a maximum immersion time of 15 minutes appeared necessary for freezing Gulf shrimp in circulating brine at +5° F. In contrast, a one-pound package of headed shrimp required four hours to freeze in still air at -20° F. Tests with immersion in still brine indicated that the time required to freeze would be about twice as long with single shrimp and several times as long with quantities of several pounds. This was due to the tendency of the shrimp to float together at the top of the brine. The rapid circulation of the brine over the top of the tank appeared important in keeping the shrimp separated and allowing optimum contact of the chilled brine with each shrimp. With the experimental brine freezer the rapid brine circulation was also found important in maintaining uniform temperature of the brine throughout the tank. Still brine or even slowly circulating brine tended to layer, a warm layer of brine appearing over the top of the cold dense brine at the bottom. The rapid circulation of brine was also necessary to keep the brine from freezing on the refrigerated coils and obstructing the flow between the coils.

Brine frozen shrimp did not take a good glaze if dipped into cold water immediately after removing from the brine. The glaze was fragile and tended to chip off readily, affording little protection from dehydration if such shrimp were stored in bulk. Brine frozen shrimp were glazed more effectively if cold water was sprayed over them in the box after the shrimp were stored for a few days at 0° F.

Brine frozen whole shrimp were found to be quite bulky, and a five-pound waxed carton held only three pounds. The brine frozen tails were slightly less bulky but still did not permit efficient packaging because of the unavoidable air space left in the carton. Even with reglazing such shrimp showed excessive dehydration because of the rapid moisture transfer within the carton.

The analyses of salt content of air and brine frozen shrimp (Table 2) showed a salt content of 0.14 to 0.46 per cent by weight in the air frozen

shrimp. The two samples of iced shrimp had a somewhat lower content than the shrimp frozen immediately at sea. The lower salt content was probably caused by the leaching effect of the melting ice. The salt content of shrimp frozen and held in brine for periods up to four hours was about 1.5 per cent. Surprisingly enough the 15-minute samples were as high in salt content as the two and four-hour samples. A significant increase was found for the 24-hour (2.1 per cent) and the 48-hour (2.4 per cent) samples. The low value of 0.16 per cent for the refrozen shrimp is interesting since it indicates that the absorbed salt was leached quite rapidly during the washing prior to refreezing. The value of 0.7 per cent for the headless shrimp frozen in brine for 15 minutes is only slightly higher than that of the whole shrimp. Commercially iced shrimp absorbed the salt more rapidly and showed an excessive salt content of 2.6 per cent after 1.5 hours in brine and 7.0 per cent after 21 hours. These shrimp were quite soft before freezing which might account for the increased absorption. Taste tests indicated that a salt content of 1.5 per cent was not excessive. If the shrimp were boiled, it was necessary to add the usual amount of salt to the water for flavoring.

Table 2. *Salt Content of Frozen Gulf Shrimp*

Sample	Description	Length of Time in brine ¹ Hours	Salt Content % by weight meat ²
<i>AF (air frozen)</i>			
1. Control	Brown shrimp, frozen immediately at sea	0	0.46
2. Iced			
a. Brown shrimp	Iced 3 days before freezing	0	0.27
b. White shrimp	Commercial lot, iced from Cameron, La.	0	0.14
<i>BF (brine frozen)</i>			
3. Refrozen	Frozen at sea, thawed, headed, refrozen ashore	0.25	0.16
4. Not refrozen			
a. Whole brown shrimp	Frozen immediately at sea	0.25 0.5 1.0 2.0 4.0 24.0 48.0	1.5 1.2 1.2 1.4 1.5 2.1 2.4
b. Whole white shrimp	Commercial sample of iced shrimp (Bayou la La.	0.5 1.0 1.5 24.0	2.0 2.5 2.6 2.6
c. Headless brown shrimp	Frozen immediately at sea	48.0 0.25	3.7 1.7
d. Headless white shrimp	Commercial sample of iced shrimp (Cameron, La.	0.5 1.0 1.5 21.0	1.9 2.2 2.6 7.0

1. 85° salometer sodium chloride brine at 5° F. plus or minus 5°.

2. Average of two or more sub-samples.

Preliminary organoleptic examinations aboard vessel of brine frozen shrimp indicated that the shrimp compared very favorably with air frozen whole and headless shrimp prepared from the same lots. Headless shrimp frozen in brine showed no discoloration on the shell or the exposed flesh. Flavor and texture of the cooked shrimp were normal, and very little salt appeared to have been absorbed by the flesh during brine freezing.

The process of thawing, heading and refreezing the brine-frozen shrimp ashore seemed to offer no problem. After thawing the shrimp were slightly softer than the fresh shrimp as taken from the water, but were definitely firmer and easier to head than much of the iced shrimp handled during the tests. The shrimp could be headed while partially frozen; however packaging was easier if the shrimp were completely thawed.

Examinations after five and eight weeks of storage (computed from the time the shrimp were first frozen) indicated that the brine frozen shrimp were equal in quality to the air-frozen shrimp. No undesirable discoloration, toughening, or excessive absorption of salt were noted in the brine-frozen shrimp. Since the brine-frozen headless shrimp were rather loosely packed in the waxed cartons, there was slight dehydration due to moisture transfer within the carton, but the quality of the shrimp as a whole did not appear to be impaired. The refrozen shrimp appeared indistinguishable from the air-frozen shrimp, and the taste panel was unable to find any differences in the flavor and texture.

After 15 weeks of storage there were no substantial changes in the quality ratings with the exception of the brine-frozen headless shrimp. The increasing dehydration of these shrimp in the loosely packed cartons was noticeable and was apparent in the difficulty of peeling the shrimp and a slightly strong off flavor. These shrimp were still in good condition but were definitely inferior to the refrozen and the air frozen samples.

After 26 weeks of storage all samples of shrimp were still in good condition except the brine-frozen headless shrimp which were rated on the borderline of marketability due to dehydration and the strong off flavor. The fact that the refrozen shrimp compared favorably at this time with the air frozen samples indicated that it was not brine freezing in itself which was the problem but rather the method of packaging which allowed dehydration. Loss of glaze was also found in the re-frozen and air-frozen shrimp which were packaged before freezing. Shrimp at the corners and edges of these packages were slightly dehydrated and the flavor and texture suffered accordingly. In brine-frozen shrimp the adverse changes accompanying dehydration were noticeably greater than with the air-frozen, possibly due to the catalytic effect of salt absorbed in the surface flesh during brine freezing. When completely protected from dehydration (e.g. shrimp from the interior of the package), samples of both brine- and air-frozen shrimp had good color, flavor and texture after the 26 weeks of storage.

After 40 weeks of storage, the dehydration of shrimp at the corners and edges of all packages of glazed shrimp was much more pronounced and made a fair comparison of the variables difficult. The further observation of these samples showed without question that brine-frozen shrimp must be even more carefully protected from such dehydration if quality is to be preserved for periods of six or nine months. The loss in quality of the air-frozen shrimp

under conditions of moderate dehydration was even so of greatest significance and was the factor limiting the storage life of these samples to nine months.

Quality comparisons of the various lots of air-frozen shrimp during the storage tests were interesting. Black spot discoloration was completely absent in shrimp frozen immediately after catching. It was present to a moderate degree in those iced three days, and to a greater degree in the commercially iced samples which were frozen. Flavor differences were apparent to members of the taste panels but preferences varied. Some seemed to find the iced shrimp more flavorsome, whereas others thought iced shrimp were too strong in flavor by comparison, and preferred the fresher flavor of the shrimp frozen immediately.

Discussion

If brine freezing of shrimp were used commercially, the re-freezing process appears to be the most satisfactory. Aboard the fishing vessel, the shrimp could be sorted rapidly into baskets in the ice water chill tank on deck. The baskets of chilled shrimp could then be removed and, after draining briefly, set in the refrigerated brine tank for freezing. After freezing, the baskets could be removed and stored in the refrigerated hold at 0° F., or the shrimp could be dumped into boxes for stacking in the hold. In either case a water spray could be used to glaze the shrimp and protect them from dehydration for the duration of the trip. Once ashore the shrimp could be thawed, headed and packaged for refreezing as desired. Alternately, they might be thawed and processed for frozen breaded shrimp or precooked shrimp products. The tests have shown that several weeks storage of the brine-frozen whole shrimp is quite practical and could be extended if shrimp are protected from dehydration. Such frozen shrimp might be used by the smaller plants for equalizing production during periods of peak fishing.

There was no evidence from these tests that brine freezing, or thawing and refreezing such shrimp caused any change from the normal color, flavor, or texture of air frozen shrimp from the same lot. Comparison of shrimp frozen at sea using absolutely fresh shrimp with iced shrimp indicated that the fresh flavor was better preserved by immediate freezing. The appearance of such shrimp frozen at sea was far superior to iced shrimp because of the complete absence of black spot discoloration. It should be emphasized that for refreezing, only the use of absolutely fresh shrimp and prompt handling during freezing, thawing, and refreezing will give the best results. Regardless of the method for freezing shrimp, there is no doubt from these tests that to adequately protect packaged glazed shrimp from dehydration, the waxed carton should be wrapped with moisture vapor-proof film. Experience with similar frozen products has shown that use of such film would eliminate the necessity of glazing if the shrimp were packed efficiently with an absolute minimum of air space within the carton.

For commercial application of brine freezing of shrimp, it is recommended that the following procedure be used: (1) Only fresh firm whole or headed shrimp should be frozen; (2) shrimp should be chilled in fresh ice water just prior to brine freezing; (3) shrimp should be removed from the brine within four hours after freezing, rinsed in cold fresh water (34°F.), stored at 0° F., and protected from dehydration; (4) the temperature of the brine should be maintained at 10° F. or lower to minimize salt absorption; and (5) brine

frozen shrimp should be thawed in fresh running water at 60° F. for 10 to 15 minutes, headed immediately, washed in fresh water, packed in waxed cartons with a minimum of air space, overwrapped with moisture vapor-proof film, and stored at 0° F. or lower.

Literature Cited

- IDYLL, CLARENCE P.; HIGMAN, JAMES B., and SIEBENALER, J. B., 1952.
Experiments on the holding of fresh shrimp in refrigerated seawater. Florida State Board of Conservation, The Marine Laboratory, University of Miami, Coral Gables, Florida. Mimeographed. 23 pp.

DISCUSSION

TECHNICAL SESSION

Discussion Leader: WAYNE M. WALLER

Discussion Panel: JOHN ROBAS, STEWART SPRINGER, JAMES BARR

- Q. Springer: Is *Sicyconia* more evident in the catch than the pink shrimp? Are they marketed at present?
- A. Howell: Yes, there are more *Sicyconia* in the catch than pink shrimp. Very small amounts are marketed at present and no attempts have been made to expand the fishery.
- Q. Strasburger: Are the reported weight of the catch heads on or heads off shrimp?
- A. Howell: Heads off.
- Q. Springer: Now is a good opportunity for the biologists to keep an eye on a fishery from the time of its discovery. Have you set up such a program?
- A. Howell: We are planning to do so.
- Q. Schaefer: What means do you have of determining fishing effort?
- A. Howell: A log book is kept on each vessel.
- Q. Barr: How much does a commercial boat catch?
- A. Howell: Seven to eight thousand pounds of shrimp per day.
- Q. Barr: How large a volume of overwrap packages are in use?
- A. Klein: These packages are used in Brownsville, Pensacola, and New Orleans.
- Q. Springer: What is the costs of such packages and how is the overwrap put on?
- A. Klein: The cartons and the overwrap are processed by hand, and it would not be too expensive in a large operation. There are considerable savings realized in shipping by this method.
- Q. Higman: Have you studied the development of black spot in overwrap packages?
- A. Klein: There was a very small amount of black spot during 12 months storage.
- Q. Strasburger: What type storage room was used? What was the differential temperature in the storage room? Was the drainage time in each experiment identical?
- A. Klein: An 8 x 10 walk-in freezer with a bush blower, using Freon 12 was used in the experiment. Air was circulated around each package. The room was at 0°F. and the air in front of blower was at 0°F. The drainage times were approximately the same.
- Q. Barr: What is the cost of this ultra-violet light equipment?
- A. Lane: The cost would be insignificant: the lamp could be bought for about \$50.00.

- Q. Robas: Why are crab plant operators so reluctant to use black light?
- A. Lane: They don't want to know how bad their crab meat really is.
- Q. Allen: Would the light tests be applicable to brown and white shrimp?
- A. Lane: It has been applied to white and pink shrimp, and I see no reason why it couldn't be used for brown.
- Q. Strasburger: Is it feasible that pH changes are dependent on bacterial flora?
- A. Lane: I would think so. In the course of natural autolysis we got a pH change that was evident.
- Q. Broadhead: Did you fail in any case to obtain phosphorescent color changes in advance of the lowering of taste panel score?
- A. Lane: The color change occurred in one instance, but it did not precede the taste panel.
- Q. Robas: Is it possible to determine the presence of mold organisms on fish nets with the black light?
- A. Lane: I am not technically equipped to answer that question.
- A. Lewis: It would probably be yes and no. Some molds phosphoresce and some don't. We found that out in our citrus work.
- Q. Lane: On what basis was the trimethylamine analysis done—dry or wet?
- A. Fieger: Wet shrimp.
- Q. Wegman: Does moonlight affect spoilage more than sunlight?
- A. Fieger: We haven't done any experimentation on that.
- Q. Wegman: Were the shrimp taken from catch boats or freight boats?
- A. Fieger: From the boat that caught them.
- Q. W. W. Anderson: Since fishermen often leave shrimp lying on deck for hours, what effect does this have on the quality of the shrimp?
- A. Fieger: In some cases, I took the word of the fishermen as to how long they left the shrimp on deck.
- O. Springer: What is the cost of the aureomycin used in the tanks?
- A. Higman: There have been no firm commitments from drug manufacturers as to the cost of the antibiotic. It should run between \$25 to \$50 per tank per trip.
- Q. Barr: Have you investigated the feelings of the Food and Drug Administration on this matter?
- A. Higman: At present there is a ruling against the use of antibiotics on food. However, it is our understanding that with proper evidence, this ruling can be altered. We are looking for the evidence.
- Q. Camber: Have any observations been made on the shrimp boats?
- A. Higman: We checked the shrimp from the minute they came on the boat till they came to the laboratory. We

went out on the boat and supervised the entire operation. The time on deck varied from one hour to an hour and a half.

Q. Barr:

What ratio of brine to shrimp was used in the tests?

A. Puncchar:

Three volumes of brine to one volume of fish were used. Ratios for brine to shrimp should be based on experimentation.

(Mr. W. L. Mingledorff, Jr., of Savannah, Ga., described experiments conducted by his company using solutions of salt and sugar as a freezing medium for shrimp).

Q. Robas:

Who mixes the solution? Does the captain mix it before the cruise?

A. Mingledorff:

We will give the exact weight of sugar and salt to the fishermen and they will be able to mix the solution with clean sea water at sea.

Q. Robas:

How much horsepower is involved for your 300 pound unit? What is the cost of your rig installed? Has anyone made any taste panel experiments on your shrimp?

A. Mingledorff:

A 25 h.p. electric system is required. The cost of installation will be around \$15,000. The A & P people have run tests on the shrimp. Dr. Fieger stated that they were exceptional in quality and Mr. Duggan is considering the possibility of its use in his plants.

Q. Fieger:

Does your product show any flavor differences from other methods of freezing? Couldn't your shrimp be dry frozen instead of immersion? Does the addition of the brine-sugar add a consistent weight?

A. Mingledorff:

The salt is overpowered by the sugar. The tip of the shrimp will pick up a taste of sugar; however, after being washed and cooked the taste panel cannot tell the difference. No blast freezing is practical on a boat. If the shrimp are allowed to drain for one hour in the hold the weight gain will be, a consistent two per cent.

Q. H. Taylor:

Is there any change of color of the shrimp in your solution?

A. Mingledorff:

No.

Q. Barr:

What would be the Food and Drug opinion on this matter of the solution?

A. Strasburger:

Since it is not an additive, Food and Drug would not be concerned.

Q. Springer:

What are the effects of climatic change on the shrimp fishery?

A. Anderson:

That is difficult to answer. Most Penaeids are tropical or sub-tropical creatures, so gradual climatic changes should not affect them too much. This family has a wide range of geographical distribution.

- Q. Barr: Is the large run of brownies in Texas due to a climatic change?
- A. Anderson: Something is happening to the population of shrimp. Brown shrimp abundance is increasing and white shrimp are decreasing in abundance. There is some indication of competition between brown and white shrimp. In the freeze of 1940 the white shrimp were almost wiped out, and there was a tremendous run of brown shrimp that year.
- Q. Robas: Do you have any clues as to the barrenness of some good trawlable area on the east coast of Florida?
- A. Anderson: The white shrimp is a mud bottom organism. The shelf from Ft. Pierce to Cape Lookout is hard sand and shell.
- Q. Wegmann: Have you ever made a survey of the West Coast of Florida around Apalachicola?
- A. Anderson: We have lost many trawls in that area. In Sarasota Bay we found the young of the brown shrimp (*Penaeus aztecus*) but we were not able to find the adults offshore. We did not tag in the Apalachicola area, so we have no data on shrimp migration in that region.
- Q. Wegmann: Are you familiar with the area around New Orleans, for instance, Lake Pontchartrain?
- A. Anderson: Yes, we tagged in Lake Pontchartrain and never got a return.
- Q. Wegmann: Are you familiar with the new shrimp grounds off Fort Myers?
- A. Idyll: It is a small area but a few boats have made good catches.
- A. Greer: Ten or 15 boats are fishing in this area.
- Q. Fieger: What per cent of tag recovery did you get?
- A. Anderson: From zero to 40 or 50 per cent. The average was 20 per cent, which is a fairly high rate of return.
- Q. Mingleorff: Do shrimp hatch in the ocean or in the rivers?
- A. Anderson: Spawning occurs in the outside waters and the young move into the bays.
- Q. Mingleorff: If we stopped fishing the roe shrimp would we enlarge the next year's fishery?
- A. Anderson: No, shrimp have tremendous reproductive capacity and it would be unwise to attempt to stop fishery on the roe shrimp.
- Q. Idyll: Did you carry on any holding experiments for natural mortalities?
- A. Anderson: We tried, and various difficulties forced us to stop. We are not at all sure that the figures would mean anything.
- Q. Wegmann: What happens to shrimp during their second year of life?
- A. Anderson: Not many shrimp live far into the second year of life.

PARTICIPANTS

GULF AND CARIBBEAN FISHERIES INSTITUTE

- Aberly, W. F.
Gibbs Corporation
Jacksonville, Fla.
- Adams, A. Maitland
Thompson Enterprises, Inc.
Key West, Fla.
- Allee, W. C.
Dept. of Zoology
University of Florida
Gainesville, Fla.
- Allen, E. A.
Marathon Corp.
Menasha, Wisc.
- Anderson, R. T.
Box 264, Brunswick, Ga.
- Anderson, William W.
Fish and Wildlife Service
Brunswick, Ga.
- Andrews, J. D.
Virginia Fisheries Laboratory
Gloucester Point, Va.
- Arata, George F., Jr.,
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Ariffi, A. J.
General Motors Corp.
224 W. 57th Street
New York, N. Y.
- Arnold, S. E.
Atlantic National Bank
Jacksonville, Fla.
- Asencio, Victor
University of Miami
Coral Gables, Fla.
- Avetta, A. J.
Seafood Machines
Pittsburgh, Pa.
- Baker, James H.
Gar-Baker Laboratories
New York, N. Y.
- Bardach, John E. D.
Department of Fisheries
University of Michigan
Ann Arbor, Mich.
- Barlow, John
Texas A and M
College Station, Texas
- Barr, James E.
Shrimp Assn. of the Americas
Brownsville, Texas
- Bassetta, Mike
Charles Bassetta and Son
Fernandina Beach, Fla.
- Benzie, Donald
State Board of Conservation
Tallahassee, Fla.
- Bettamio de Azevedo, Mario H.
Brazilian Navy
Presidential Apts. B624
Philadelphia 3, Penna.
- Bevis, Charlie
State Board of Conservation
Tallahassee, Fla.
- Bindloss, John B.
Atlantic States Marine Fisheries
Comm.
Stonington, Conn.
- Blackmer, R. C.
Diesel Corporation
St. Augustine, Fla.
- Blanche, Gaston
Martinique, F.W.I.
- Boa, Manuel
Key West, Fla.
- Boe, Peter
Norwegian Embassy
Washington, D. C.
- Bolton, D. A.
Donald A. Bolton and Co.
Jacksonville, Fla.
- Bowling, Charles B.
Dept. of Agriculture
Washington, D. C.
- Bromfield, I.
Bromfield Manufacturing Co., Inc.
246-288 Border Street
East Boston 28, Mass.
- Broadhead, Gordon
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Bunker, John
Christian Science Monitor
Washington, D. C.

- Burrows, Robert F.
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Caldwell, David
University of Florida
Gainesville, Fla.
- Camber, C. Isaac
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Carpenter, W. H.
Savannah, Ga.
- Carranza, Enrique R. A.
Argentine Naval Commission
12 West 56th Street
New York 19, N. Y.
- Cerniglia, William J.
University of Miami
Coral Gables, Fla.
- Chapelle, H. I.
F.D.R. No. 1
Cambridge, Md.
- Chapin, Henry
South Miami, Fla.
- Chew, Frank
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Christensen, P. A.
Burmeister & Wain's
Maskin-og Skibsbyggeri
Copenhagen, Denmark
- Clark, Oliver J.
Clark Seafood Co.
Brownsville, Texas
- Clark, W. P.
McPhillips Packing Corp.
Mobile, Ala.
- Clegg, J. R.
J. R. Clegg and Sons
Brownsville, Texas
- Clifford, Chester
Murphy Diesel
Savannah, Ga.
- Cohen, Irving J.
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Collins, R. E.
Ocean Products Co.
Tampa, Fla.
- Conhagen, Alfred
Hydraulik A/S,
429 West 17th Street
New York 11, N. Y.
- Cook, William
Meletio Seafood Co.
Miami, Fla.
- Cope, Edward B.
Business Week
Houston, Texas
- Corbett, Exteen
Nassau Fertilizer and Oil Co., Inc.
Fernandina Beach, Fla.
- Corbino, S. W.
Fishing Gazette
Arabi, La.
- Corson, Allen
Miami Herald
Miami, Fla.
- Craig, J. M.
Jacksonville, Fla.
- Crawford, Carlton
Crawford Packing Co.
Palacios, Texas
- Daniel, H. Morgan
Alphen Seafood of Texas, Inc.
Port Lavaca, Texas
- Darlington, S. P.
Shelley Tractor & Equipment Co.
Miami, Fla.
- David, Thomas E., Speaker
Florida House of Representatives
Hollywood, Fla.
- Davis, Roland
University of Miami
Coral Gables, Fla.
- Davy, C. J.
Detroit Diesel, General Motors
Detroit, Mich.
- Day, Albert M.
Fish and Wildlife Service
Washington, D. C.
- De Fever, Arthur
701 E. Harbor Drive
San Diego, Calif.

- Desmarais, Antonio A.
Triumph Continental Products Ltd
637 Craig Street.
Montreal, P.Q., Canada
- Dietrich, O., Director
Klockner Humbolt Denta A. G.
Cologne, Germany
- Doxey, A. M.
Walter Kidde & Co.
675 Main Street
Bellville, N. J.
- Duerk, E. G.
Jacksonville, Fla.
- Duggan, J. Roy
SeaPak Corporation
St. Simon's Island, Ga.
- Eacho, S. A.
Carlton Fisheries
Brownsville, Texas
- Eacho, W. Carlton
Carlton Fisheries
Morgan City, La.
- Eddy, Robert Lee, Jr.
Wildlife and Fisheries Comm.
New Orleans, La.
- Ellison, W. A., Jr., Director
Fisheries Research Institute
Morehead City, N. C.
- Erwin, John H.
Shelby Paper Box Co.
Memphis, Tenn.
- Estlander, Eric
Raadmand Steins Alle 21
Copenhagen, Denmark
- Faubion, John J., Jr.
First State Bank
Port Lavaca, Texas
- Fellows, H. E.
Nordberg Mfg. Co.
Milwaukee, Wisc.
- Felton, Berlin
A & B Fish Co.
Key West Fla.
- Ferguson, John C.
St. George Packing Co.
Fort Myers, Fla.
- Ferlisi, Fred A.
Marine Supply and Oil Co.
St. Augustine, Fla.
- Fernandois, Arturo
Corporacion de Fomento de la
Produccion
37 Wall Street
New York 5, N. Y.
- Ferreira, Hector
Pesquera e Industrialiazdora de
Guaymas
Guaymas, Sonora, Mexico
- Fieger, Ernest A.
Louisiana State University
Baton Rouge, La.
- Field, Crosby
New York, N. Y.
- Fischer, Louis
Fischer Seafoods
Cocoa, Fla.
- Fitch, Keith A.
Orkin Institute of Industrial
Sanitation
Atlanta, Ga.
- Frank, Lewis
Mariscos del Carmen, S. A.
Carmen, Mexico
- Gallagher, N. E.
Detroit Waste Works
Detroit, Mich.
- Galtsoff, Paul S.
Fish and Wildlife Service
Woods Hole, Mass.
- Gehris, George
Florida State Board of Health
Jacksonville, Fla.
- Ginsberg, Robert
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Godfrey, George R.
Coastal Freezing Plant
Aransas Pass, Texas
- Godfrey, Walter
Western Shellfish Co.
Brownsville, Texas
- Goodman, M. L.
Marine Sales
Baldwin Lima Hamilton Corp.
60 E. 42nd Street
New York 7, N. Y.
- Gosling, Ambrose
Government of Bermuda
Shelly Bay, Bermuda

- Gould, David
Georgia State Game & Fish Comin.
Brunswick, Ga.
- Gould, W. C.
Diesel Engine Corp.
General Motors
1775 Broadway
New York 19, N. Y.
- Greene, S. I.
Ho-Ma Packing Co.
Chicago, Ill.
- Greer, Billy F.
Fish and Wildlife Service
Coral Gables, Fla.
- Gresh, W. A.
Fish and Wildlife
Atlanta, Ga.
- Grownlow, D. L., Director
Mirrless Bickerton & Day
Mirrless Works
Hazel Grove, Stockport, England
- Gueroult, E. R.
Assoc. Technique Maritime et
Aeronautique
47, rue de Maubeuge
Paris, France
- Gunn, Dudley
Gulf States Marine Fisheries
Commission
New Orleans, La.
- Hall, Y. E.
Y. E. Hall Insurance
Fernandina Beach, Fla.
- Hambidge, Gove
F.A.O., United Nations
Washington, D. C.
- Hampton, Wm. F.
Birds Eye Division
General Foods Corp.
1 Fish Pier
Boston, Mass.
- Hanson, H. C.
102 Colman Ferry Terminal
Seattle, Wash.
- Hardee, I. W.
Standard Hardware Co.
Fernandina Beach, Fla.
- Hardee, J. B.
Standard Hardware Co.
Tampa, Fla.
- Hardee, Will
Box 329
Brownsville, Texas
- Hardy, A. C.
London
England
- Harris, Virgil
Fish and Wildlife Service
Coral Gables, Fla.
- Heater, Jack
New York, N. Y.
- Hela, Ilmo
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Hendry, W. J.
Okeechobee, Fla.
- Hettler, Washington H.
Fishing Gazette
New York, N. Y.
- Heydecker, Wayne D.
Atlantic States Marine Fisheries
Comm.
Mt. Vernon, N. Y.
- Higman, James B.
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Hile, Ralph
Fish and Wildlife Service
Ann Arbor, Mich.
- Hines, William S.
Dept. of Trade and Industry
Halifax, Nova Scotia
- Hoben, E. W.
Caterpillar Tractor Co.
Peoria, Ill.
- Hobson, Ben
Meletio Seafood Co.
St. Louis, Mo.
- Hoover, Walter B.
Southern Fisherman
New Orleans, La.
- Howard, Sheldon K.
Fairbanks Morse & Co.
760 Lee Street, S. W.
Atlanta, Ga.
- Howell-Rivero, Luis
University of Havana
Havana, Cuba

- Hoyos, Francisco
F.A.O., United Nations
Rome, Italy
- Hudson, Alver
Wildlife & Fisheries Comm.
New Orleans, La.
- Huet, G. O.
Higgins, Inc.
P. O. Box 8001,
New Orleans, La.
- Hughes, John
Linen Thread Company
Baltimore, Md.
- Hvish, Melvin
Game & Freshwater Fish Comm.
Tallahassee, Fla.
- Idyll, C. P.
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Jackson, Charles E.
National Fisheries Institute
Washington, D. C.
- Jacobsen, Erik
Consulate General of Denmark
17 Battery Place
New York 4, N. Y.
- Joseph, Edwin B.
Tulane University
New Orleans, La.
- Jul, Mogens
Chief Fisheries Technologist
F.A.O., United Nations
Rome, Italy
- Kahn, Richard A.
Fish & Wildlife Service
Washington, D. C.
- Kennedy, Thomas M.
Kennedy Marine Engine Co.
Biloxi, Miss.
- Kennedy, W. P., Jr.
Kennedy Marine Engine Co.
Biloxi, Miss.
- Key, S. A.
Key Fish Co.
Port Lavaca, Texas
- Klein, Marian
Marathon Corporation
Menasha, Wisc.
- Knapp, Frank
Georgia State Game & Fish Comm.
Brunswick, Ga.
- Kuhlman, W. G.
Detroit Diesel Engine Div.
General Motors
Detroit, Mich.
- Labrie, Arthur, Deputy Minister
Quebec Dept. of Fisheries
Montreal, P. Q.
- Lanasa, Mike
Lanasa Shrimp Co.
Key West, Fla.
- Lane, Charles E.
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Langlois, Thomas H.
Stone Institute of Hydrobiology
Put-in-Bay, Ohio
- Lares, Arturo
Consul General of Venezuela
Miami, Fla.
- Lawrence, Ewing, Jr.
Electronics Distributors
Jacksonville, Fla.
- Leipper, Dale F.
Texas A and M
College Station, Texas
- Levinson, L. D.
Ocean Products
Tampa, Florida
- Lewis, Arthur
University of Miami
Coral Gables, Fla.
- Long, E. John
Bethesda, Md.
- Lindblom, Jarl
Abo (Turku) Finland
- Ludwig, Charles
Ludwig Shrimp Co.
Miami, Fla.
- Lynch, C. W.
St. George Packing Co.
Fort Myers, Fla.
- Madero, Daniel C.
Productos Refrigerados, S. A.
Mexico, D. F.
- Madero, Mauricio B.
Productos Refrigerados, S. A.
Mexico, D. F.

- Mairs, Edwin H.
4116 Douglas Road
Miami, Fla.
- Malaier, J. H.
Modern Maid Food Products, Inc.
Jamaica, N. Y.
- Malton, George B.
Amerio Contract Plate Freezers, Inc.
Union City, N. J.
- Mani, S. B.
Dept. of Fisheries
Govt. of India
c/o Marine Laboratory
University of Miami
Coral Gables, Fla.
- Mann, William
Mellenger, Ltd.
407 McGill Street
Montreal, P. Q.
- Mansell, D. W.
Brush Abee, Inc.
60-07 39th Avenue
Woodside, L. I., N. Y.
- Marsh, Richard F.
Farrell Birmingham Co., Inc.
Ansonia, Conn.
- McBride, E. F.
Baldwin Lima Hamilton Corp.
Philadelphia, Pa.
- McCuller, E. O.
Home Insurance Co.
Jacksonville, Fla.
- McDaniel, Ruel
Quick Frozen Foods
Port Lavaca, Texas
- McHugh, J. L., Director
Virginia Fisheries Laboratory
Gloucester Point, Va.
- MacIntyre, David
Aluminum Co. of America
New Kensington, Pa.
- McNary, William F.
Caterpillar Tractor Co.
P. O. Box 1038
Portland, Me.
- McNeir, G. W.
La Marque, Texas
- McPhillips, James
Southern Fisheries Corp.
Mobile, Ala.
- Mefford, H. P.
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Meitin, H. A.
St. Augustine National Bank
St. Augustine, Fla.
- Meyer, Max
Meyer Fish and Produce Co.
Jacksonville, Fla.
- Miller, J. B.
Miller Bros.
St. Mary's, Ga.
- Miller, William C.
Wm. C. Miller & Assoc.
577 Spreckles Bldg.
San Diego 1, Calif.
- Miller, William T.
U. S. Dept. of Interior
Government House
St. Thomas, Virgin Islands
- Mingledorff, W. L., Jr.
Savannah, Ga.
- Minot, Francis
Marine Fisheries Eng. Res. Inst.
Woods Hole, Mass.
- Moore, Hilary B.
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Moore, Donald R.
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Mowbray, Louis S.
Government Aquarium & Museum
Flatts, Bermuda
- Mullette, R. S.
U. N. Korean Agency
New York, N. Y.
- Munson, Walter S.
Minneapolis-Honeywell
Regulator Co.
Seattle, Wash.
- Murdock, James F.
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Murphy, Charles
Wildlife & Fisheries Comm.
New Orleans, La.

- Myers, R. L.
Ederer, Inc.
Philadelphia, Pa.
- Naranjo, Aldolfo
Banco de Fomento Agricola e
Industrial de Cuba
Havana, Cuba
- Nickum, George C.
W. C. Nickum & Sons
300 Polson Bldg.
Seattle 4, Wash.
- Norris, Julian D.
Kenyon Parsons & Co.
Jacksonville, Fla.
- O'Connell, Robert V.
Rochester Ropes
Culpepper, Va.
- Oliver, Marshall
Morehead City Yacht Basin
Morehead City, N. C.
- O'Neill, W. L.
Campbell Soup Co.
Camden, N. J.
- Orrson, Waldo
Southern Fisherman
New Orleans, La.
- Part, John
Esotex Co., Inc.
Port Isabell, Texas
- Pashos, Lou
Brownsville Shrimp Exchange
Brownsville, Texas
- Peace, H. L.
H. L. Peace Publications
New Orleans, La.
- Penso, Leonard E.
Merchant Marine Technical
Division
U. S. Coast Guard
Washington, D. C.
- Petrich, James
Western Boat Building Co.
P. O. Box 1114
Tacoma 1, Wash.
- Perez-Farfante, Isabel
Centro de Investigaciones
Pesqueras
Havana, Cuba
- Phillips, Craig
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Pickett, Richard E.
68 Sunnyside Avenue
Brooklyn 7, N. Y.
- Pinson, Pedro L., Pres.
Shrimp Association of the
Americas
Mazatlan, Sin., Mexico
- Poli, D. J.
Marine Supply and Oil Co.
St. Augustine, Fla.
- Prechtel, George S.
The Edwin H. Fidler Rope Co.
Philadelphia, Pa.
- Pritchard, A. L.
Department of Fisheries
Ottawa, Canada
- Prussing, R.,
C. M. Diesel Export
224 W. 57th Street
New York 19, N. Y.
- Puncochar, J. F.
Fish and Wildlife Service
Boston, Mass.
- Ramirez, Raul J.
Productos Refrigerados S. A.
Carmen, Mexico
- Rice, G. C.
John's Pass Fish Co.
St. Petersburg, Fla.
- Ringhaver, L. C.
Diesel Engine Sales
St. Augustine, Fla.
- Rishell, C. A.
Timber Engineering
Washington, D. C.
- Robas, John S.
Fernandina Beach, Fla.
- Roberts, J. C.
Enterprise Engine & Machine Co.
New Orleans, La.
- Robida, A. J., Chairman, Bd. of Dir.
Southeastern Fisheries Ass'n
Jacksonville, Fla.
- Robinson, H. R.
Robinson Canning Co.,
Westwego, La.

- Rochester, W. L., Jr.
Rochester Ropes, Inc.
Culpepper, Va.
- Rosenberg, John H.
Florida Fisherman's Supply Co.
Tampa, Fla.
- Rowell, John W.
Cummins Engine Company, Inc.
Columbus, Ind.
- Rowland, J.
Fishery Council
New York, N. Y.
- Rubin, Ed.
East Coast Fisheries
Miami, Fla.
- Rumpf, Bill
St. George Packing Co.
Fort Myers, Fla.
- Sahlman, H. F., President
Southeastern Fisheries Ass'n
Fernandina Beach, Fla.
- Salvador, Felix
S. Salvador Sons
Tampa, Fla.
- Salvador, John
S. Salvador Sons
St. Augustine, Fla.
- Sanchez, Jorge
Presa Rodriguez 33
Mexico 10, D. F.
- Sanchez, Manuel
Brownsville Shrimp Exchange
First National Bank Bldg.
Brownsville, Texas
- Santa Maria, Carlos
Corporacion de Fomento de la
Produccion
37 Wall Street
New York, N. Y.
- Schaefer, M. B.
Inter Am. Tropical Tuna Comm.
La Jolla, Calif.
- Schevill, William E.
Woods Hole Oceanographic
Institute
Woods Hole, Mass.
- Schmitt, Waldo
Smithsonian Institution
Washington, D. C.
- Schulman, George W.
George W. Schulman Co.
New Orleans, La.
- Schulman, Mary
Assistant Attorney General
Tallahassee, Fla.
- Scott, Donald
Dept. of Biology
University of Georgia
Athens, Ga.
- Sembler, Charles W.
Sebastian, Fla.
- Shapiro, Sidney
Fish and Wildlife Service
Washington, D. C.
- Siebenaler, J. B.
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Shaw, H. W.
Gulf Crest Fisheries
Jacksonville, Fla.
- Shepard, Ted
George W. Schulman Co.
New Orleans, La.
- Singleton, H. C.
Singleton Shrimp Co.
Tampa, Fla.
- Smith, A. L.
Frostie Frozen Foods
Brownsville, Texas
- Smith, F. G. Walton, Director
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Smith, Gilbert P.
The Smith Meal Co.
Amagansett, L. I., N. Y.
- Smith, Harvey W.
J. Howard Smith Co.
Port Monmouth, N. J.
- Smith, Paul F.
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Sooder, E.
Miami, Fla.
- Springer, Stewart
Fish and Wildlife Service
Pascagoula, Miss.

- Stallone, Joe
Southeastern Fisheries Ass'n
Miami, Fla.
- Starace, Thomas
University of Miami
Coral Gables, Fla.
- Steele, George, Exec. Secy.
Southeastern Fisheries Ass'n
Jacksonville, Fla.
- Steele, Raymond
American Seafood Distributors
Ass'n
Washington, D. C.
- Stephens, Olin J. II
Sparkman & Stephens, Inc.
79 Madison Avenue
New York, N. Y.
- Stobinski, Frank R.
Alfred Canhagen, Inc.
429 West 17th Street
New York, N. Y.
- Stong, D. G.
Cummins Agent Co.
Atlanta, Ga.
- Strasburger, L. W.
Envoldsen Shrimp Inc.
New Orleans, La.
- Suarez, Jose A.
Centro de Investigaciones Pesqueras
Havana, Cuba
- Suttkus, R. D.
Department of Zoology
Tulane University
New Orleans, La.
- Swartz, Joe
East Coast Fisheries
Miami, Fla.
- Swartz, Max
East Coast Fisheries
Miami, Fla.
- Taylor, Charles T.
Federal Reserve Bank
Atlanta, Ga.
- Taylor, Francis W.
Warren Fish Co.
Pensacola, Fla.
- Taylor, Harden F.
New York, N. Y.
- Taylor, Porter V.
Frozen Food Age
South Miami, Fla.
- Thomson, James
Linen Thread Co.
Bradenton, Fla.
- Thompson, James
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Thornwell, George
Gulf Stream Quick Freeze
Miami, Fla.
- Thurman, George
Birmingham, Ala.
- Torres Curbelo, Jose M.
Marine Banco de Fomento Agricola
e Industrial de Cuba
Lonja Comercio
Havana, Cuba.
- Traung, Jan-Olof
Naval Architect, FAO,
United Nations
Rome, Italy
- Udell, Larry
Miami, Fla.
- Usina, Charles F.
Atlantic States Marine Fisheries
St. Augustine, Fla.
- van Gelderen, Ph.
Netherlands Embassy
Washington, D. C.
- Venis, George
Southeastern Fisheries Ann'n
Jacksonville, Fla.
- Versaggi, John
Versaggi Shrimp Co.
Patterson, La.
- Versaggi, Joseph
Versaggi Shrimp Co.
New York, N. Y.
- Versaggi, M. J.
Versaggi Shrimp Co.
Tampa, Fla.
- Versaggi, Virgil
Versaggi Shrimp Co.
Brownsville, Texas
- Vibrans, Frank C., Jr.
Fairbanks, Morse & Co.
Beloit, Wis.
- Voltaggio, Frank J.
Ho-Ma Packing Co.
Brownsville, Texas

- Voltaggio, Morris
Valley Fisheries
Port Isabell, Texas
- Voss, Gilbert
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Wallace, David H., Director
Oyster Institute of North America
Annapolis, Md.
- Waller, Wayne M.
H. J. Baker & Son
Baltimore, Md.
- Warren, Zygmunt
Mexico, D. F.
- Walters, John P.
630 S. W. 69th Avenue
Miami, Fla.
- Wegmann, A. J.
Bagille's Seafood Co.
New Orleans, La.
- Weil, Leo
Fulton Fish Market
Louisville, Ky.
- Wheeler, Murray
National Fisheries Institute
Washington, D. C.
- West, John B.
Aluminum Co. of America
1800 Rhodes-Haverty Bldg.
Atlanta, Ga.
- Whiteleather, Richard
Fish and Wildlife Service
Washington, D. C.
- White-Spunner, S. E.
Merchants National Bank
Mobile, Ala.
- Whittaker, Edward
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Wiles, Dudley
Department of Science and
Agriculture
Barbados, British West Indies
- Wilmot, Morris D.
Gibbs Corporation
P.O. Box 4190
Jacksonville, Fla.
- Williams, Frank A. M.
George Engine Co., Inc.
Harvey, La.
- Wynne, Sheldon S.
University of Miami
Coral Gables, Fla.
- Young, D. K.
Shelby Paper Box Co.
San Antonio, Texas
- Young, Robert H.
Marine Laboratory
University of Miami
Coral Gables, Fla.
- Yourkevitch, Vladimir
Yourkevitch Ship Designs Co.
50 Broad Street
New York 4, N. Y.
- Zepeda, Manuel
Hijos de M. Zepeda
Carmen, Mexico

